

| Mode                 | Data rate<br>(Mbps) | Target application          | Receiver<br>sensitivity | Power consumption ('2001) |             |
|----------------------|---------------------|-----------------------------|-------------------------|---------------------------|-------------|
|                      |                     |                             |                         | Rx. average               | Tx. average |
| Mode 1.0 (Bluetooth) | 1 Mbps              |                             | -84 dBm                 | 25 mW                     | 15 mW       |
| Mode 2.0             | 2.6-3.9 Mbps        | Audio                       | -78 dBm                 | 30 mW                     | 20 mW       |
| Mode 3.0             | 22-44 Mbps          | Video, computer<br>graphics | -69 dBm                 | 95 mW                     | 60 mW       |

Figure 1

Configuration 1: Audio  
and internet streaming  
applications

Mode 1.0  
(Bluetooth)

Mode 2.0, rate  
**2.6-3.9 Mbps**

Configuration 2:  
video, computer  
graphics

Mode 1.0  
(Bluetooth)

Mode 3.0, rate  
22-44 Mbps

Figure 2

| Parameters                | Mode 1 (Bluetooth) | Mode 2                                  |
|---------------------------|--------------------|---|
| Frequency hopping         | 1600 Hz            | Same as Bluetooth                       |
| Filter spectrum           |                    | Same as Bluetooth <del>16, 64 QAM</del> |
| Modulation                | GFSK               | 16, 64 QAM                              |
| Maximum data rate         | 1 Mbps             | 2.6, 3.9 Mbps                           |
| Acquisition               |                    | Using mode 1 then switch to mode 2      |
| Transmit power            | 0 dBm              | 0 dBm, 6 dBm                            |
| Distance                  | 10 m.              | 10 m.                                   |
| Nominal packet error rate | 10 %               | 10 %                                    |
| Margin + Noise figure     | 37 dB              | 37 dB                                   |
| Receiver sensitivity      | -84 dBm            | -84, -78 dBm                            |
| Coding                    | ARQ                | ARQ + convolutional code across packets |

Figure 3

| Frequency offset | Transmit power |
|------------------|----------------|
| +/- 550 kHz      | -20 dBc        |
| $ M-N  = 2$      | -20 dBm        |
| $ M-N  \geq 3$   | -40 dBm        |

Figure 4

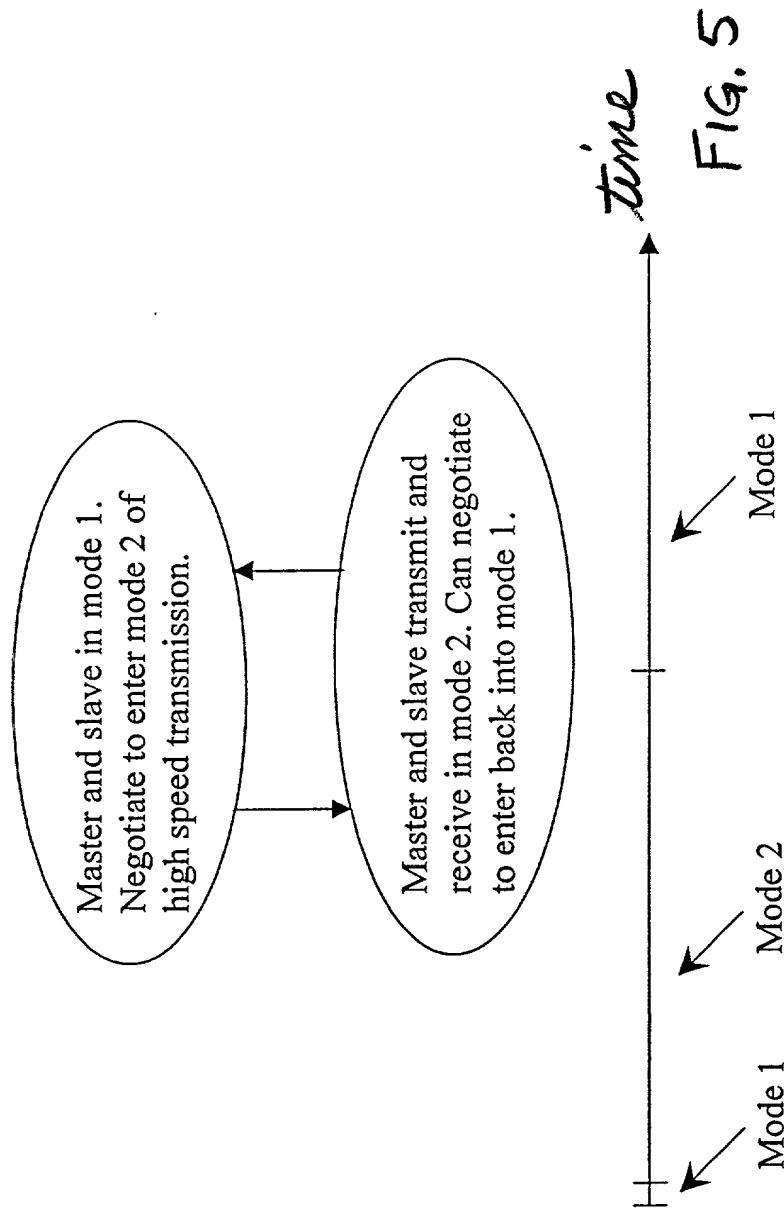


FIG. 5

| LSB             | 20 symb.        | 32 symb.        | 27 symb. | 0-1780 symb.      | MSB |
|-----------------|-----------------|-----------------|----------|-------------------|-----|
| Preamble        | Sync. Word      | Header          |          | Payload           |     |
| 30.8 $\mu$ sec. | 49.2 $\mu$ sec. | 41.5 $\mu$ sec. |          | 0-2738 $\mu$ sec. |     |

20 bits      64 bits      54 bits      0-7120 bits for 16 QAM  
 0-10680 bits for 64 QAM

Figure 6

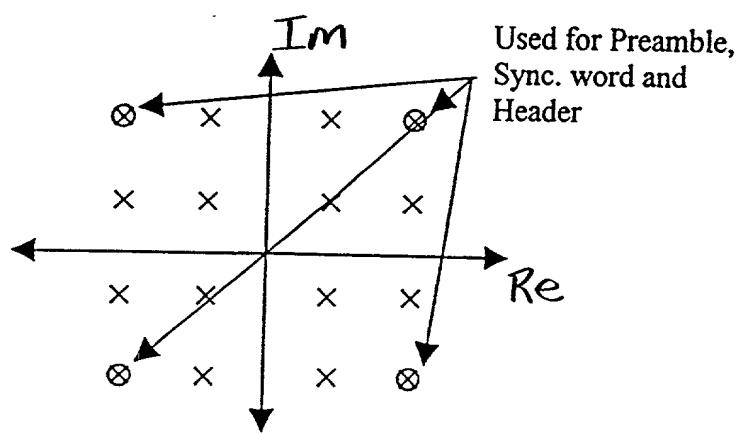


Figure 6A

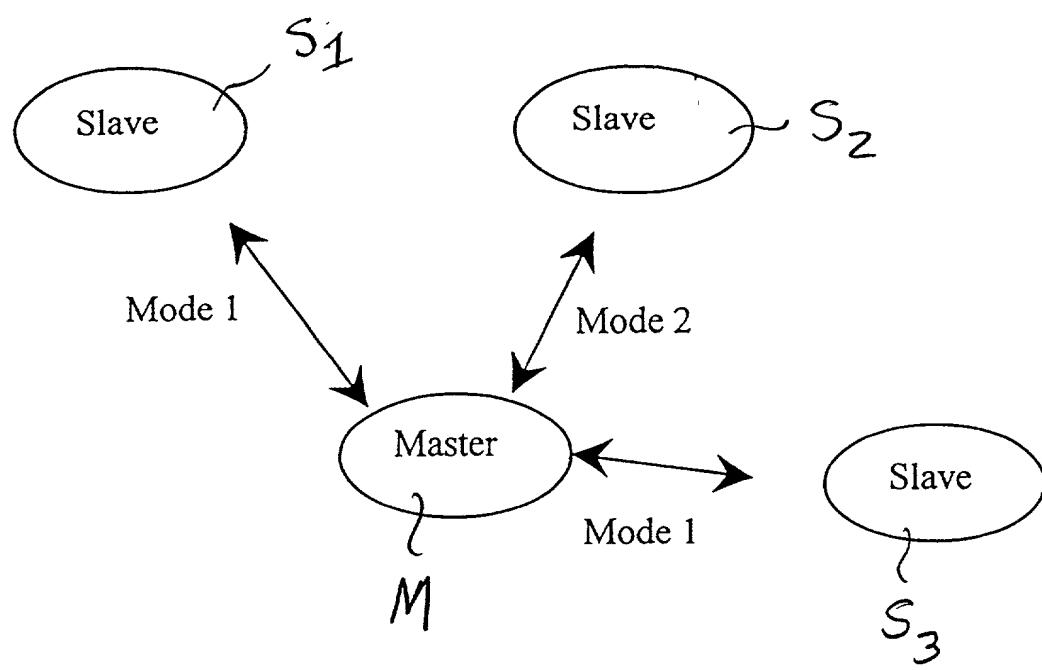


Figure 7

| M      | $S_1$  | M      | $S_2$  | M      | $S_3$  | M      | $S_1$  | M      | $S_2$  | M      | $S_3$  |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Mode 1 | Mode 1 | Mode 2 | Mode 2 | Mode 1 | Mode 1 | Mode 1 | Mode 1 | Mode 2 | Mode 2 | Mode 1 | Mode 1 |

$\xrightarrow{\text{time}}$

Figure 8

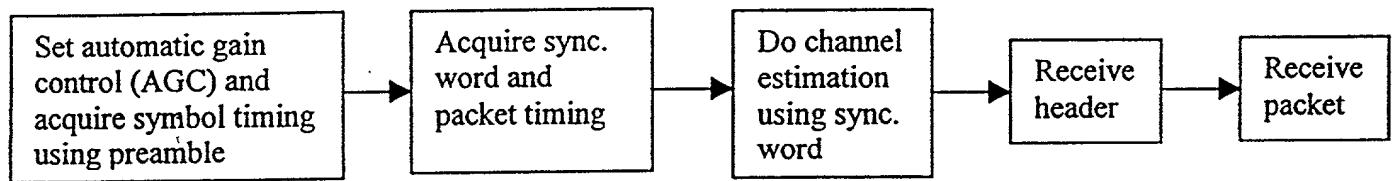


Figure 9

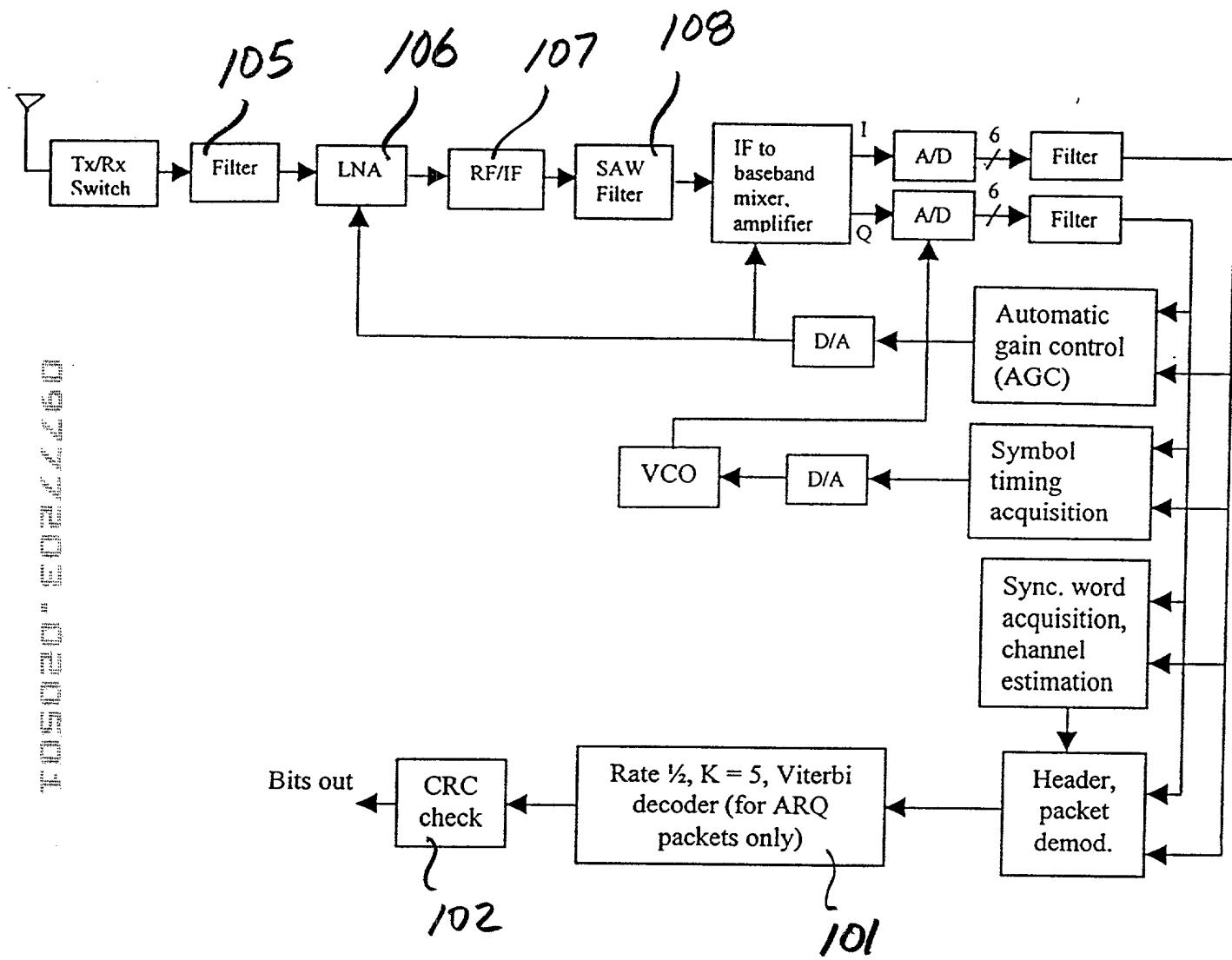


Figure 10

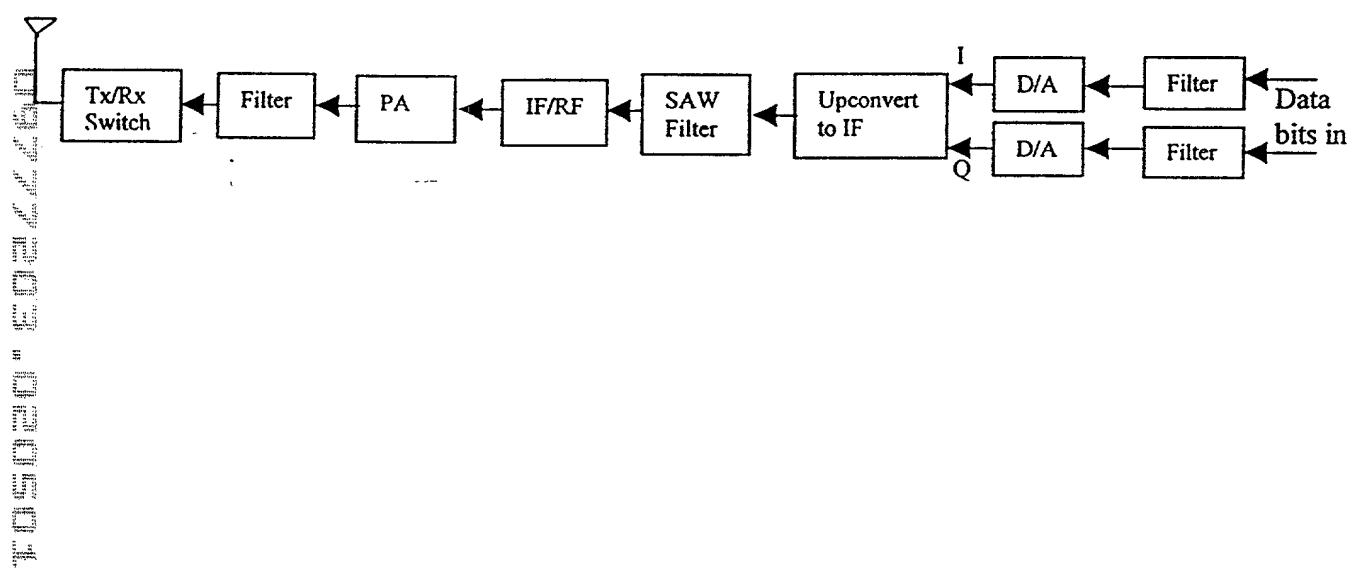


Figure 11

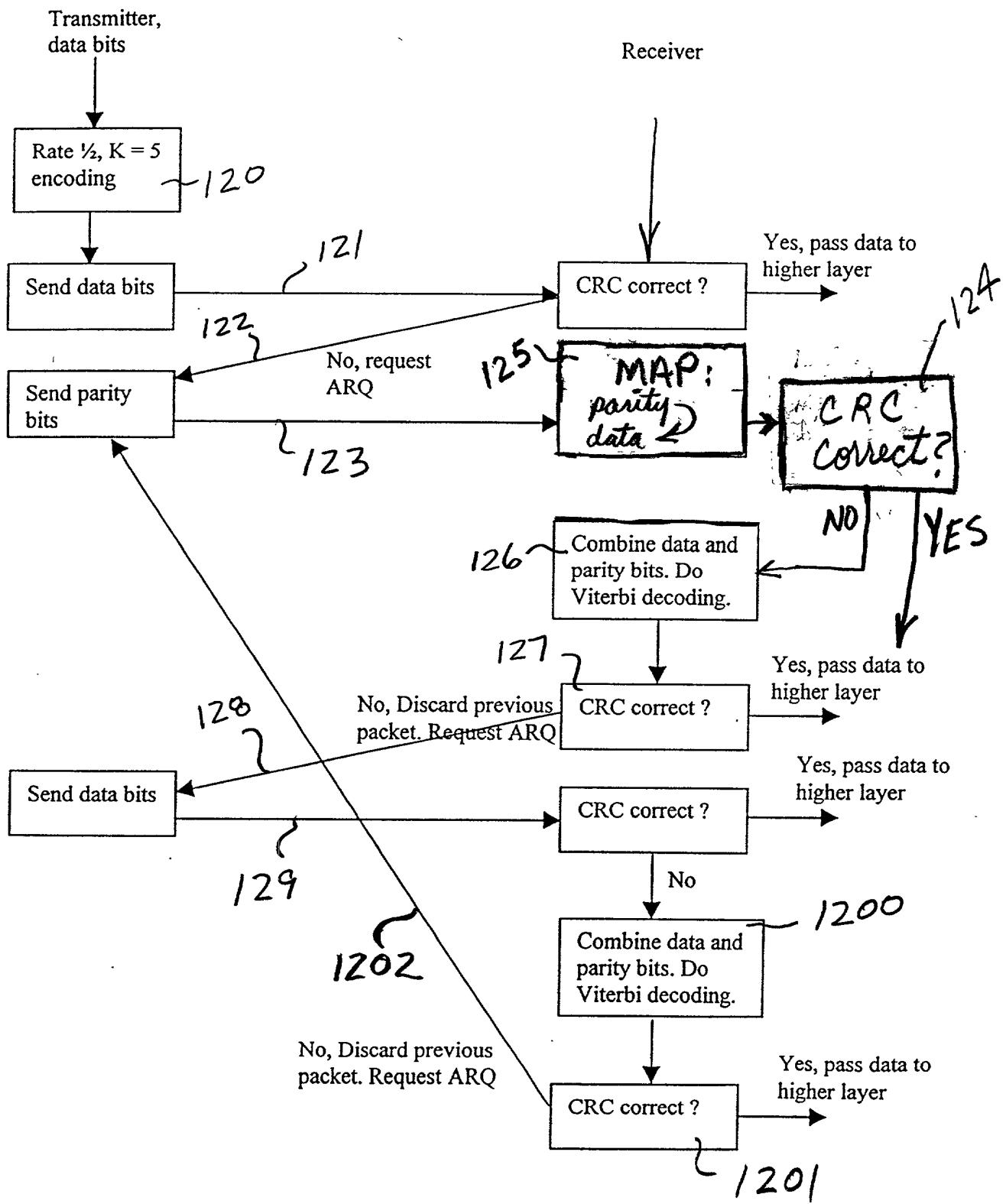


Figure 12

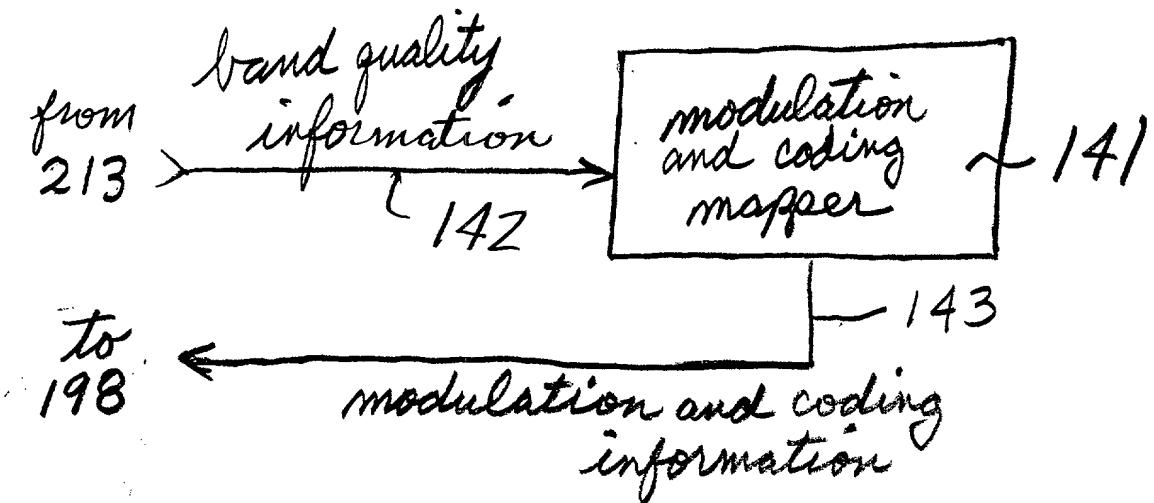
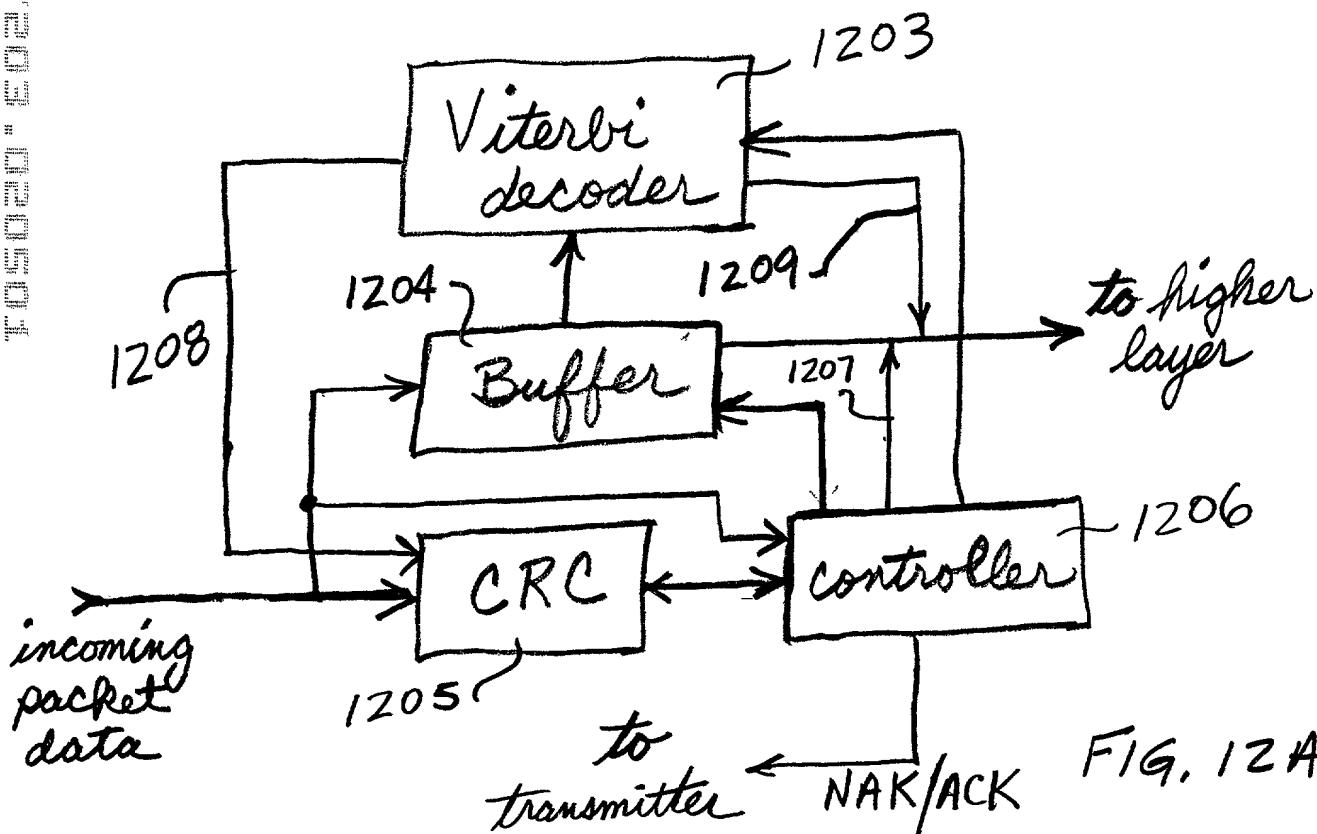


FIG. 14B



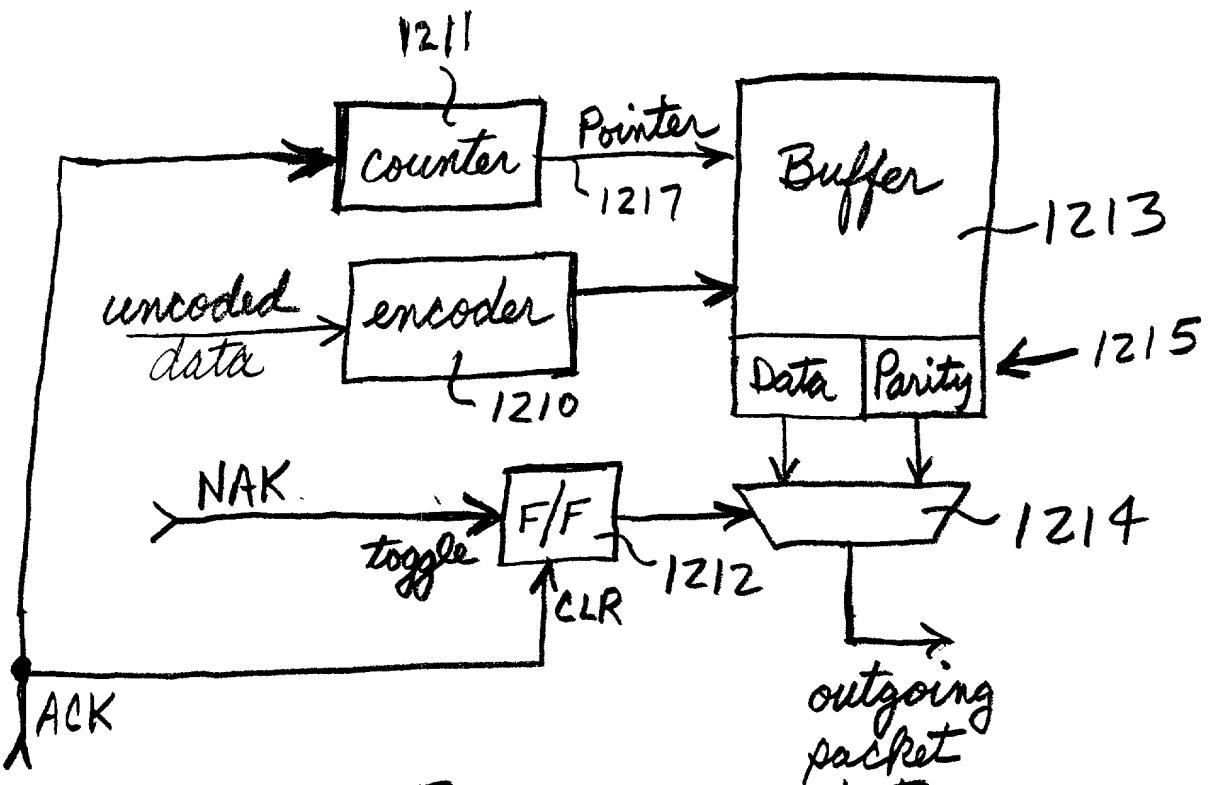


FIG. 12B

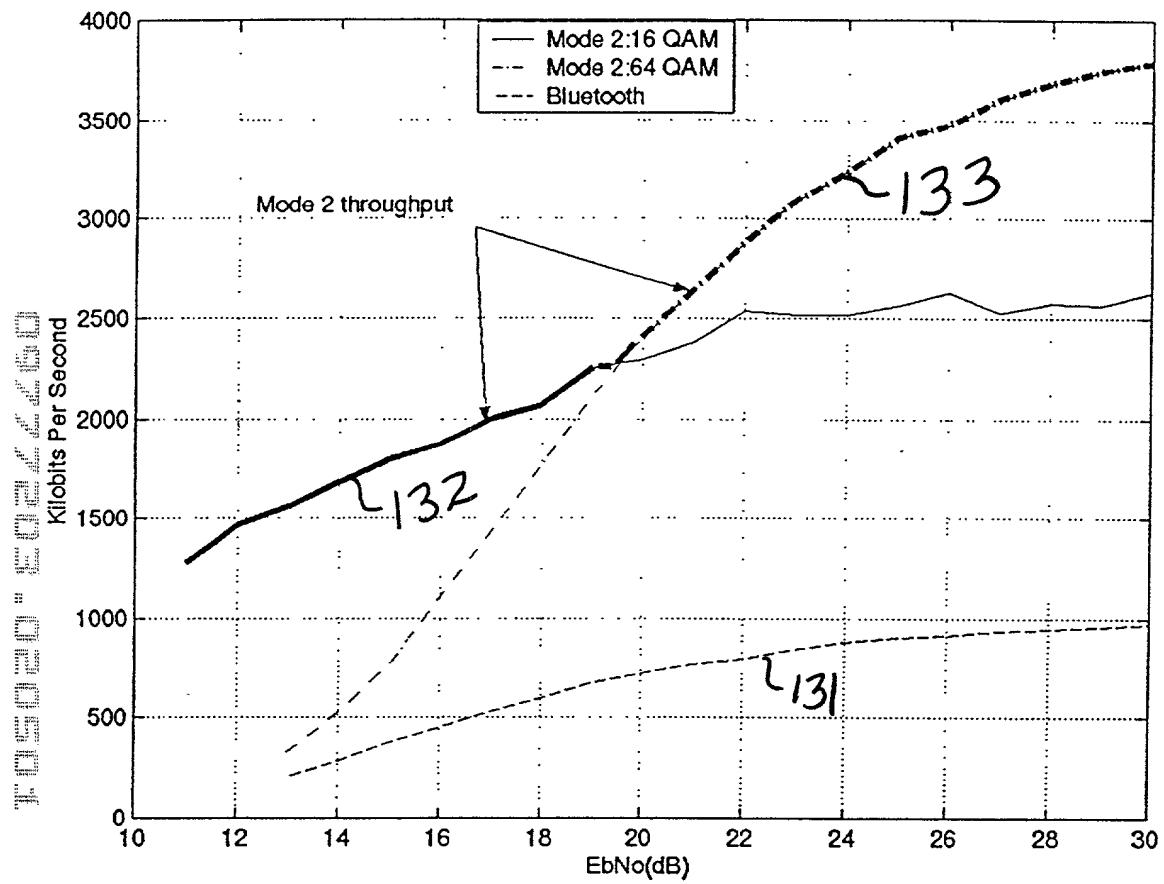


Figure 13

| Parameters             | 1                                 | 2              | 3                                 | 4                                 | 5              |
|------------------------|-----------------------------------|----------------|-----------------------------------|-----------------------------------|----------------|
| Filter spectrum        | 802.11b                           | 802.11b        | 802.11b                           | 802.11b                           | 802.11b        |
| Modulation             | QPSK                              | QPSK           | 16 QAM                            | 16 QAM                            | 16 QAM         |
| Scrambling code length | 256                               | 256            | 256                               | 256                               | 256            |
| Physical data rate     | 22 Mbps                           | 22 Mbps        | 44 Mbps                           | 44 Mbps                           | 44 Mbps        |
| Coding                 | Rate $\frac{1}{2}$ , Turbo (SCCC) | None           | Rate $\frac{1}{2}$ , Turbo (SCCC) | Rate $\frac{3}{4}$ , Turbo (SCCC) | None           |
| ARQ                    | Optional                          | Optional       | Optional                          | Optional                          | Optional       |
| Maximum data rate      | 11 Mbps                           | 22 Mbps        | 22 Mbps                           | 33 Mbps                           | 44 Mbps        |
| Transmit power         | -1 dBm                            | 8 dBm          | 4 dBm                             | 8 dBm                             | 15 dBm         |
| Distance               | 10 m.                             | 10 m.          | 10 m.                             | 10 m.                             | 10 m.          |
| Bit error rate         | 1e-8                              | 1e-8           | 1e-8                              | 1e-8                              | 1e-8           |
| Packet error rate      | 1e-4                              | 1e-4           | 1e-4                              | 1e-4                              | 1e-4           |
| Margin+Noise figure    | 37 dB                             | 37 dB          | 37 dB                             | 37 dB                             | 37 dB          |
| Receiver sensitivity   | -85 dBm                           | -76 dBm        | -80 dBm                           | -76 dBm                           | -69 dBm        |
| Frequency diversity    | Band selection                    | Band selection | Band selection                    | Band selection                    | Band selection |
| SYMBOL RATE            | 11 Msps                           | 11 Msps        | 11 Msps                           | 11 Msps                           | 11 Msps        |
| SPREADING              | 11 Mcps                           | 11 Mcps        | 11 Mcps                           | 11 Mcps                           | 11 Mcps        |

Figure 14

| <u>Max. data rate</u> | Modulation | Symbol rate | Coding  | Spreading |
|-----------------------|------------|-------------|---------|-----------|
| 18                    | 18 Mbps    | QPSK        | 18 Msps | rate 1/2  |
| 19                    | 36 Mbps    | QPSK        | 18 Msps | rate 1    |
| 20                    | 36 Mbps    | 16 QAM      | 18 Msps | rate 1/2  |
| 21                    | 54 Mbps    | 16 QAM      | 18 Msps | rate 3/4  |
| 22                    | 72 Mbps    | 16 QAM      | 18Msps  | rate 1    |

FIG. 14A

| Parameters             | 6                          | 7                          | 8                          | 9                          | 10                         |
|------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| Filter spectrum        | 802.11b                    | 802.11b                    | 802.11b                    | 802.11b                    | 802.11b                    |
| Modulation             | QPSK                       | QPSK                       | QPSK                       | QPSK                       | QPSK                       |
| Scrambling code length | 256                        | 256                        | 256                        | 256                        | 256                        |
| Physical data rate     | 22 Mbps                    |
| Coding                 | Rate $\frac{1}{2}$ , Turbo | Rate $\frac{2}{3}$ , Turbo | Rate $\frac{3}{4}$ , Turbo | Rate $\frac{4}{5}$ , Turbo | Rate $\frac{5}{6}$ , Turbo |
| ARQ                    | Optional                   | Optional                   | Optional                   | Optional                   | Optional                   |
| Maximum data rate      | 11 Mbps                    | 14.67 Mbps                 | 16.5 Mbps                  | 17.6 Mbps                  | 18.33 Mbps                 |

FIG. 14C

| Parameters             | 11       | 12              | 13              | 14              | 15              | 16              | 17              |
|------------------------|----------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Filter spectrum        | 802.11b  | 802.11b         | 802.11b         | 802.11b         | 802.11b         | 802.11b         | 802.11b         |
| Modulation             | 8-PSK    | 8-PSK           | 8-PSK           | 8-PSK           | 8-PSK           | 8-PSK           | 8-PSK           |
| Scrambling code length | 256      | 256             | 256             | 256             | 256             | 256             | 256             |
| Physical data rate     | 33 Mbps  | 33 Mbps         | 33 Mbps         | 33 Mbps         | 33 Mbps         | 33 Mbps         | 33 Mbps         |
| Coding                 | None     | Rate 1/3, Turbo | Rate 1/2, Turbo | Rate 2/3, Turbo | Rate 3/4, Turbo | Rate 4/5, Turbo | Rate 5/6, Turbo |
| ARQ                    | Optional | Optional        | Optional        | Optional        | Optional        | Optional        | Optional        |
| Maximum data rate      | 33 Mbps  | 11 Mbps         | 16.5 Mbps       | 22 Mbps         | 24.75 Mbps      | 26.4 Mbps       | 27.5 Mbps       |

FIG. 14D

| Frequency offset    | Transmit power |
|---------------------|----------------|
| $f_c$               | 0 dBc          |
| $\pm 11\text{MHz}$  | -30 dBc        |
| $\pm 22\text{ MHz}$ | -50 dBm        |

Figure 15

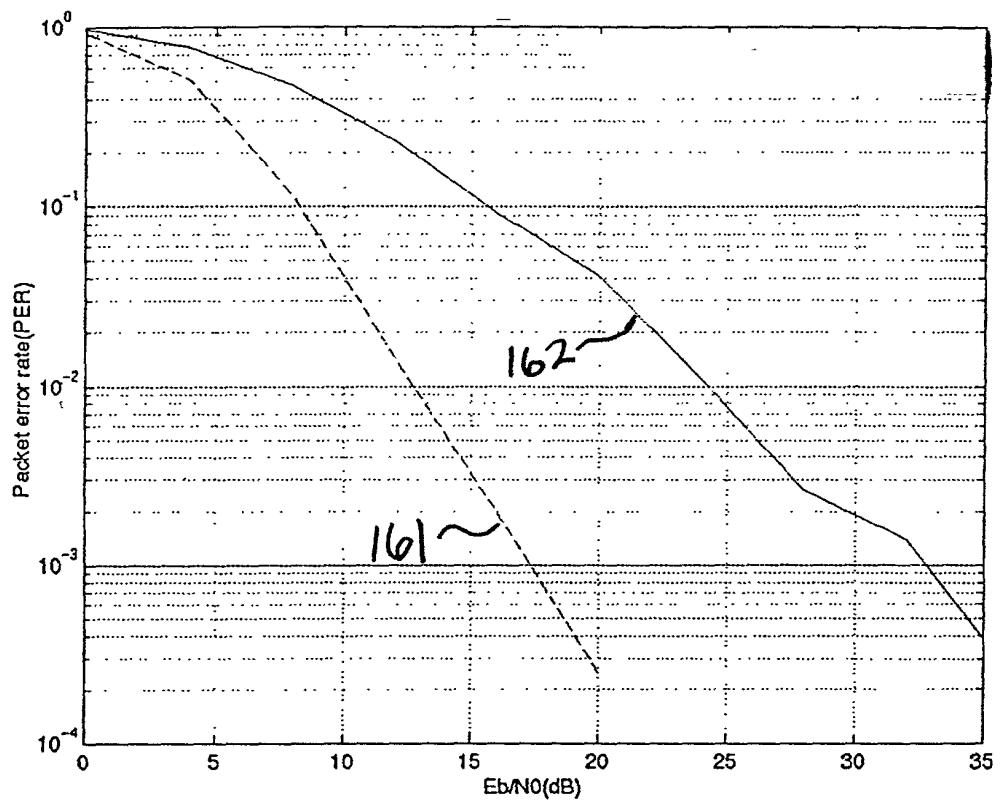


Figure 16

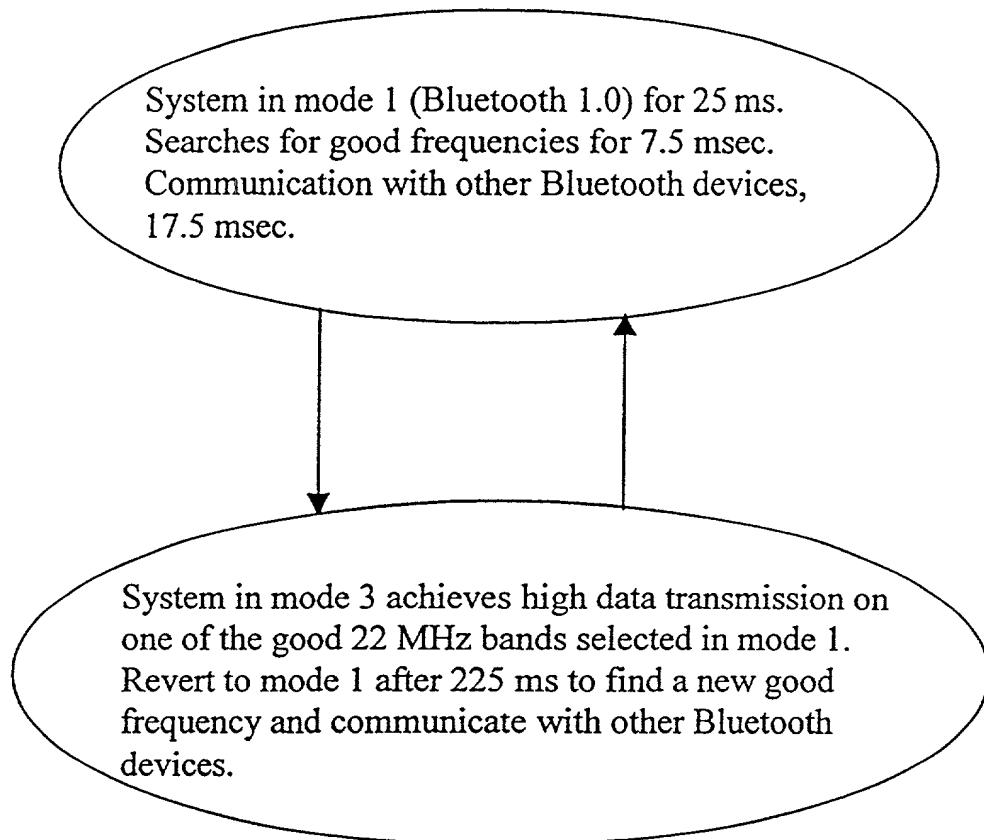


Figure 17

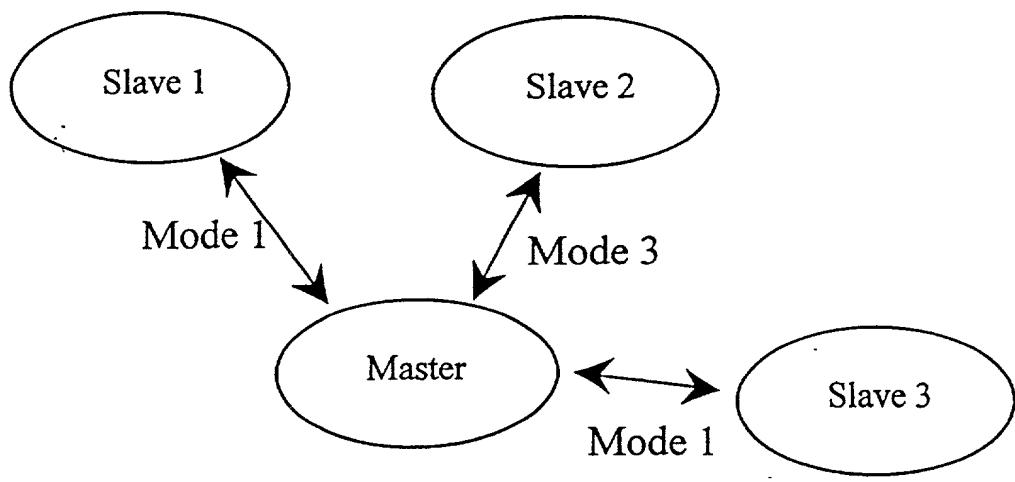


Figure 18

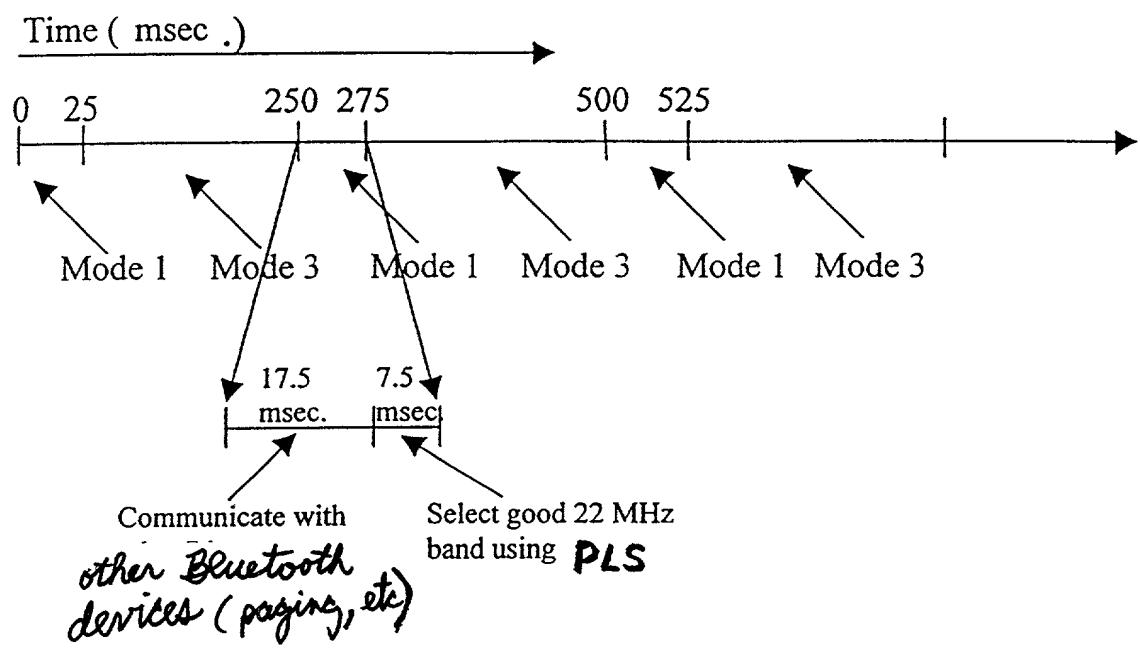
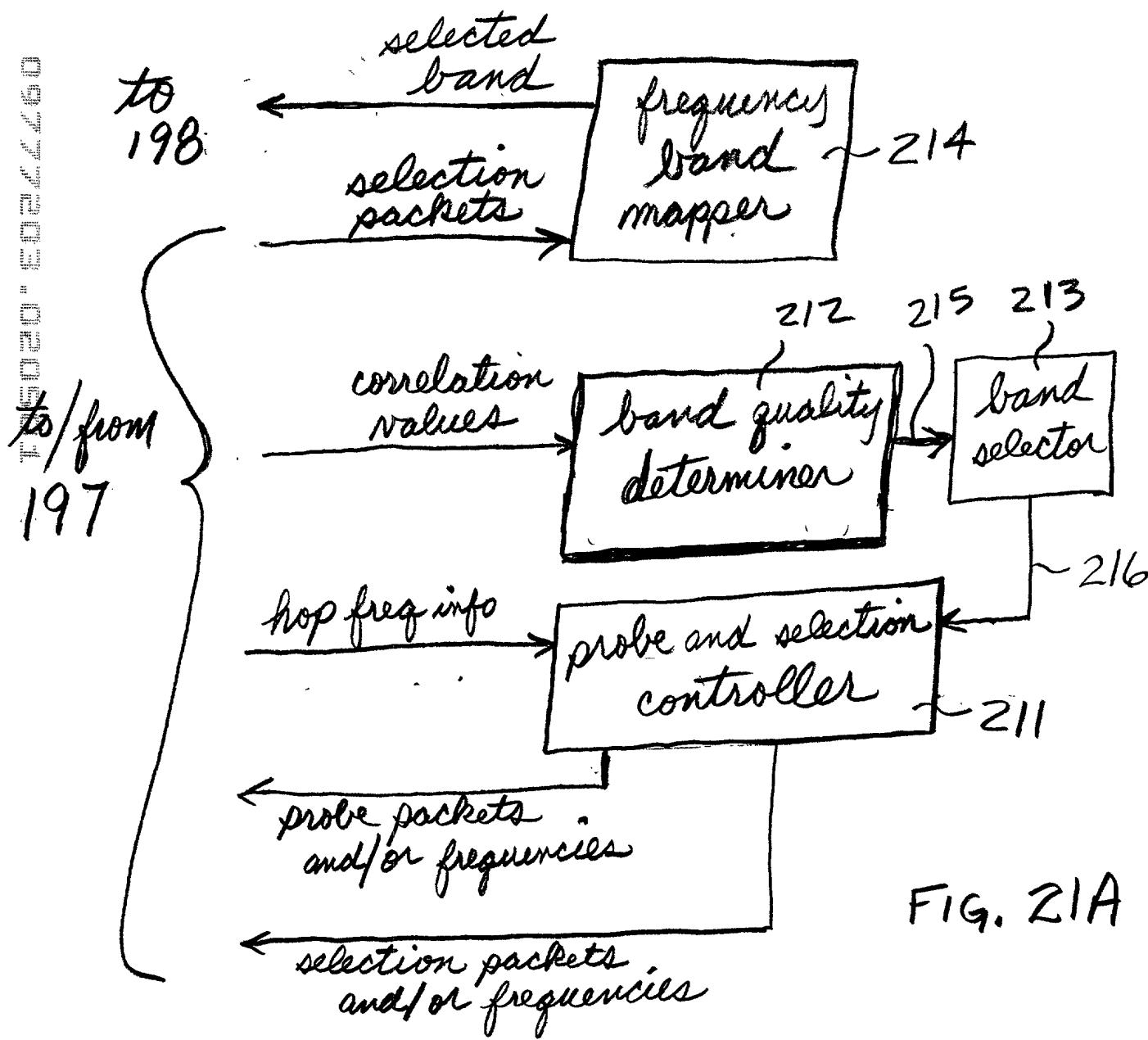
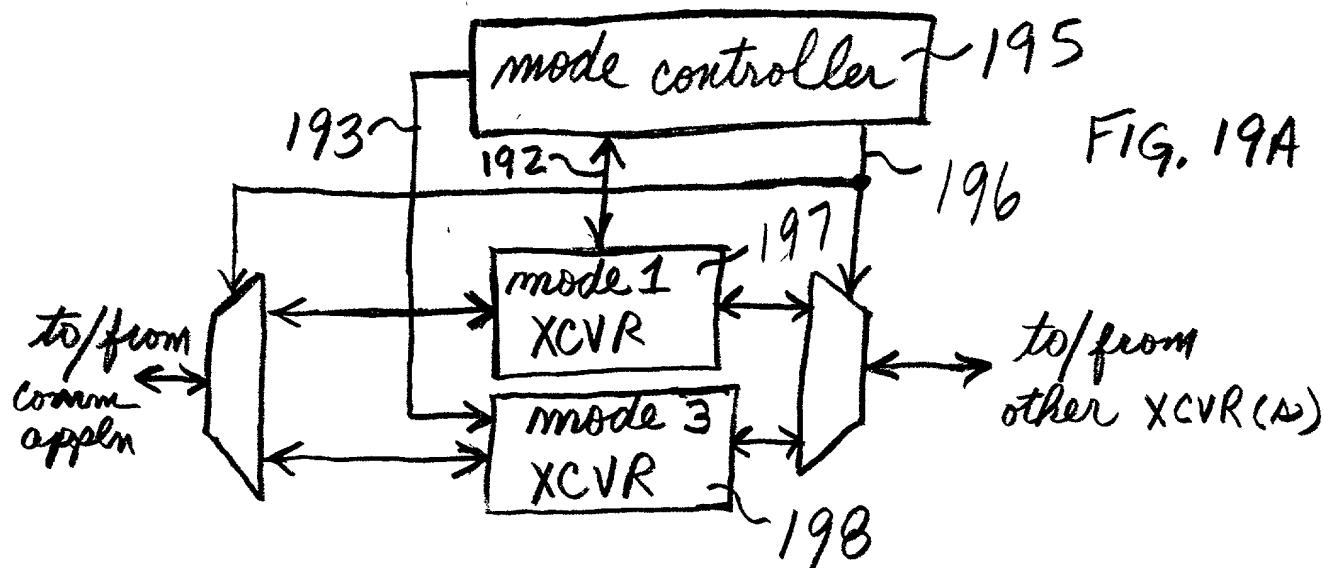


Figure 19



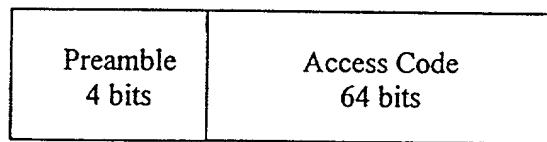


Figure 20

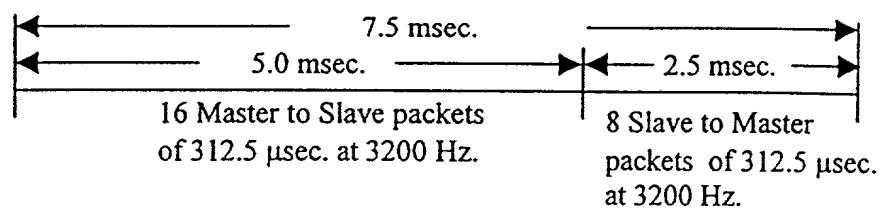


Figure 21

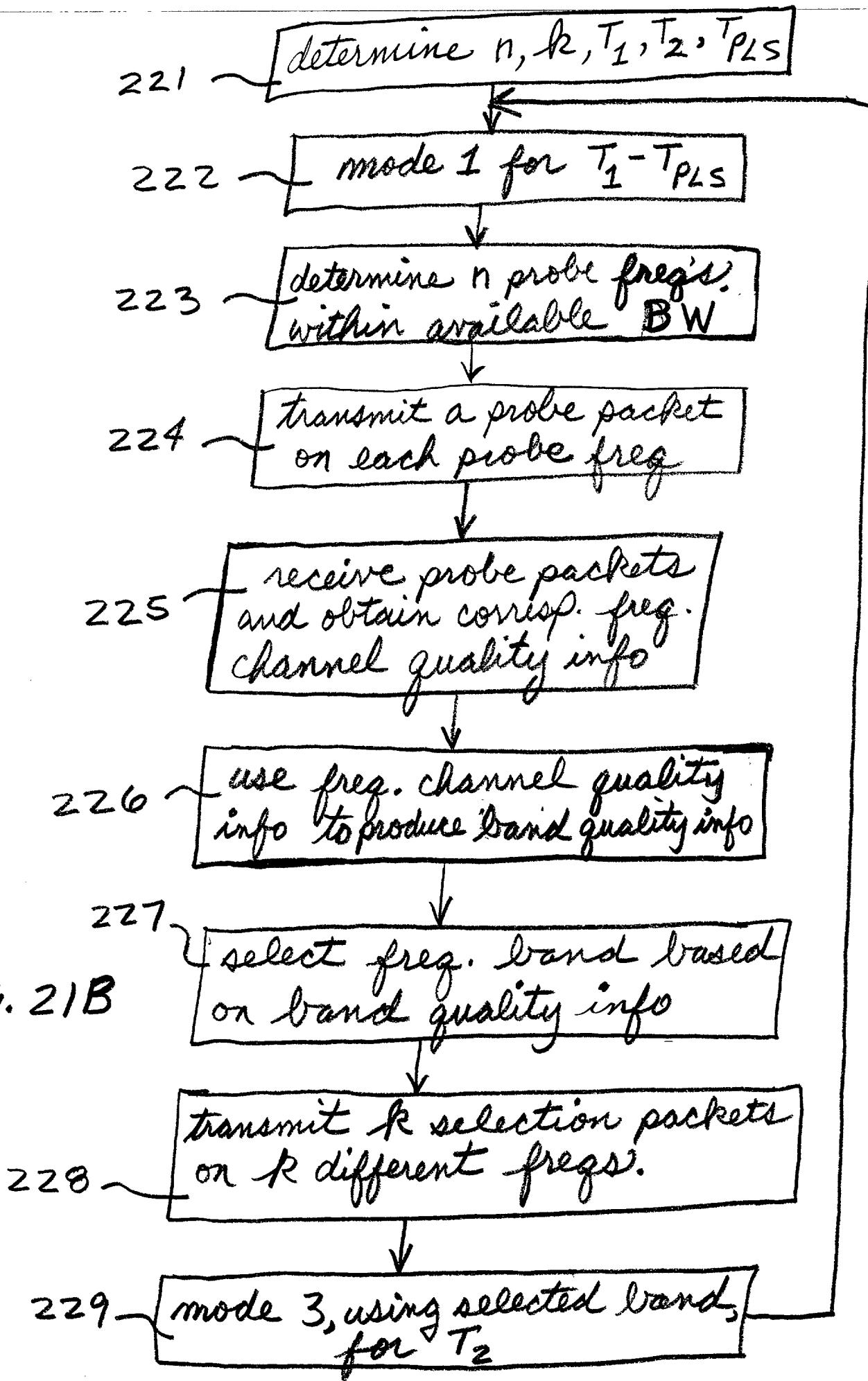


FIG. 21B

|                    |                        |  |
|--------------------|------------------------|--|
| Preamble<br>4 bits | Access Code<br>64 bits | Channel Edge<br>Frequency Index<br>$6*3 = 18$ bits |
|--------------------|------------------------|--|

Figure 22

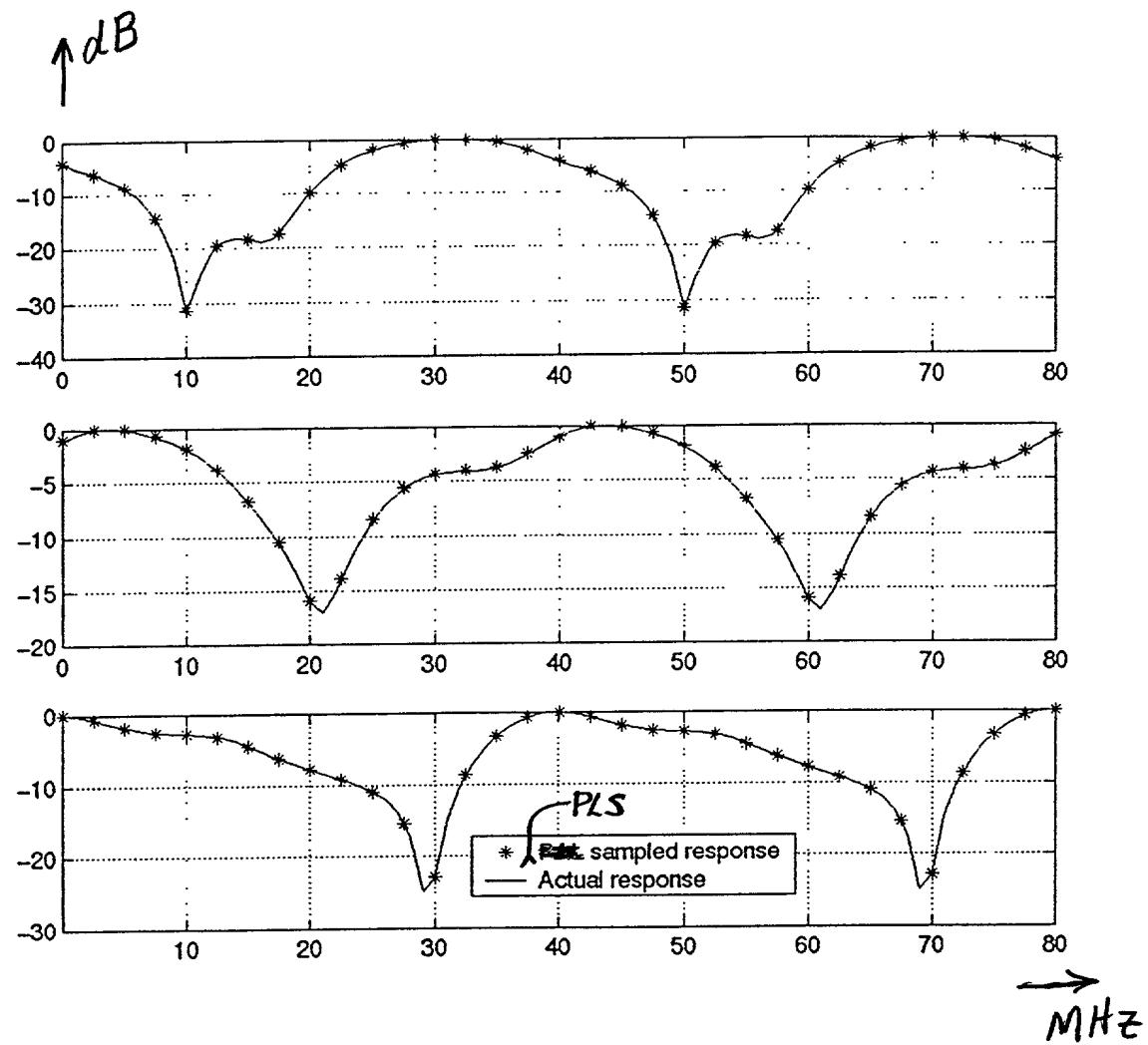
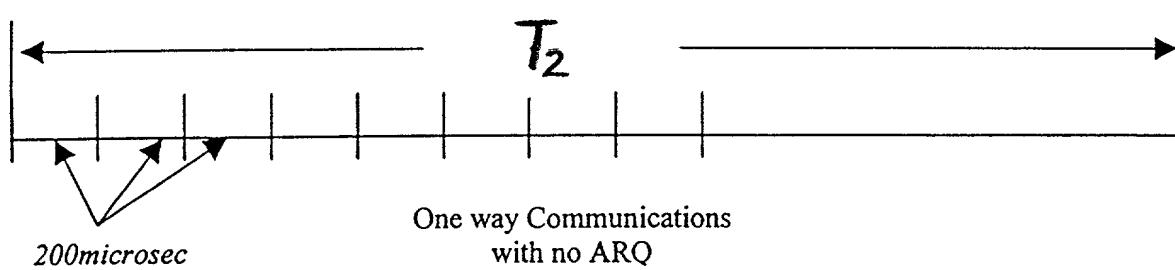


Figure 23

## Master to Slave



ARQ Packets from Slave to Master  
100  $\mu$ sec. in length.

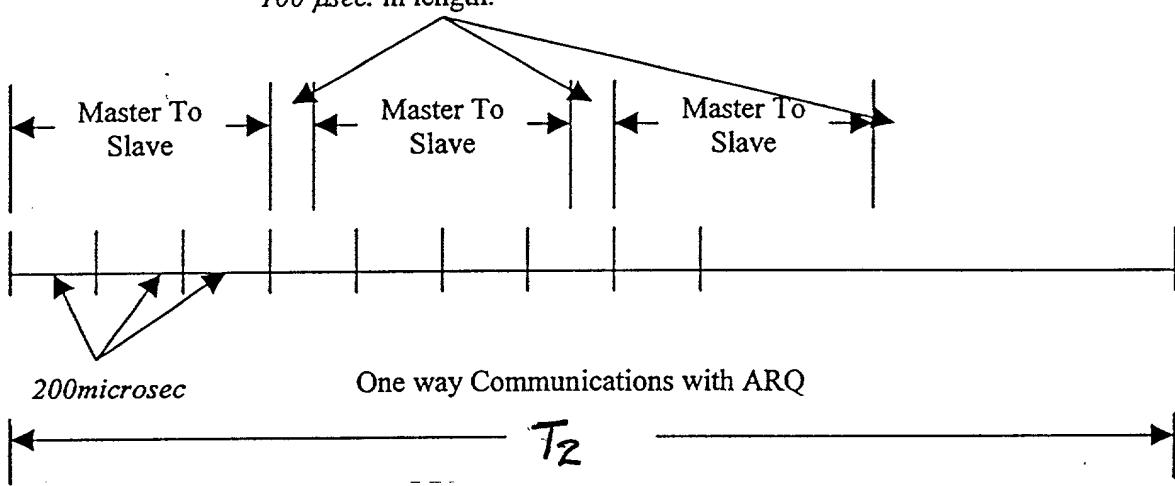


Figure 24

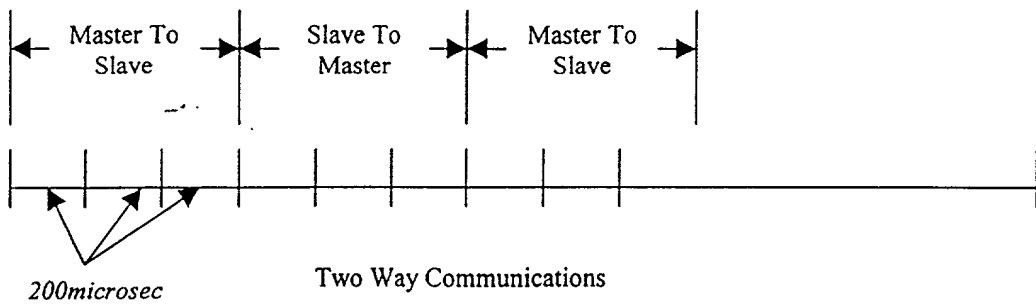


FIG. 24A

|                                | 22 symb.             | 32 symb.                 | 27 symb.              | 1019 symb.                               |  |                                |
|--------------------------------|----------------------|--------------------------|-----------------------|--|--|--------------------------------|
| 100 $\mu$ sec turn around time | Preamble 2 $\mu$ sec | Sync. Word 2.9 $\mu$ sec | Header 2.45 $\mu$ sec | Payload (100 bits), CRC repetition coded |  | 100 $\mu$ sec turn around time |
|                                | 44 bits              | 64 bits                  | 54 bits               | 32 bits                                  |  |                                |

100  $\mu$ sec ARQ packet length

FIG. 25A

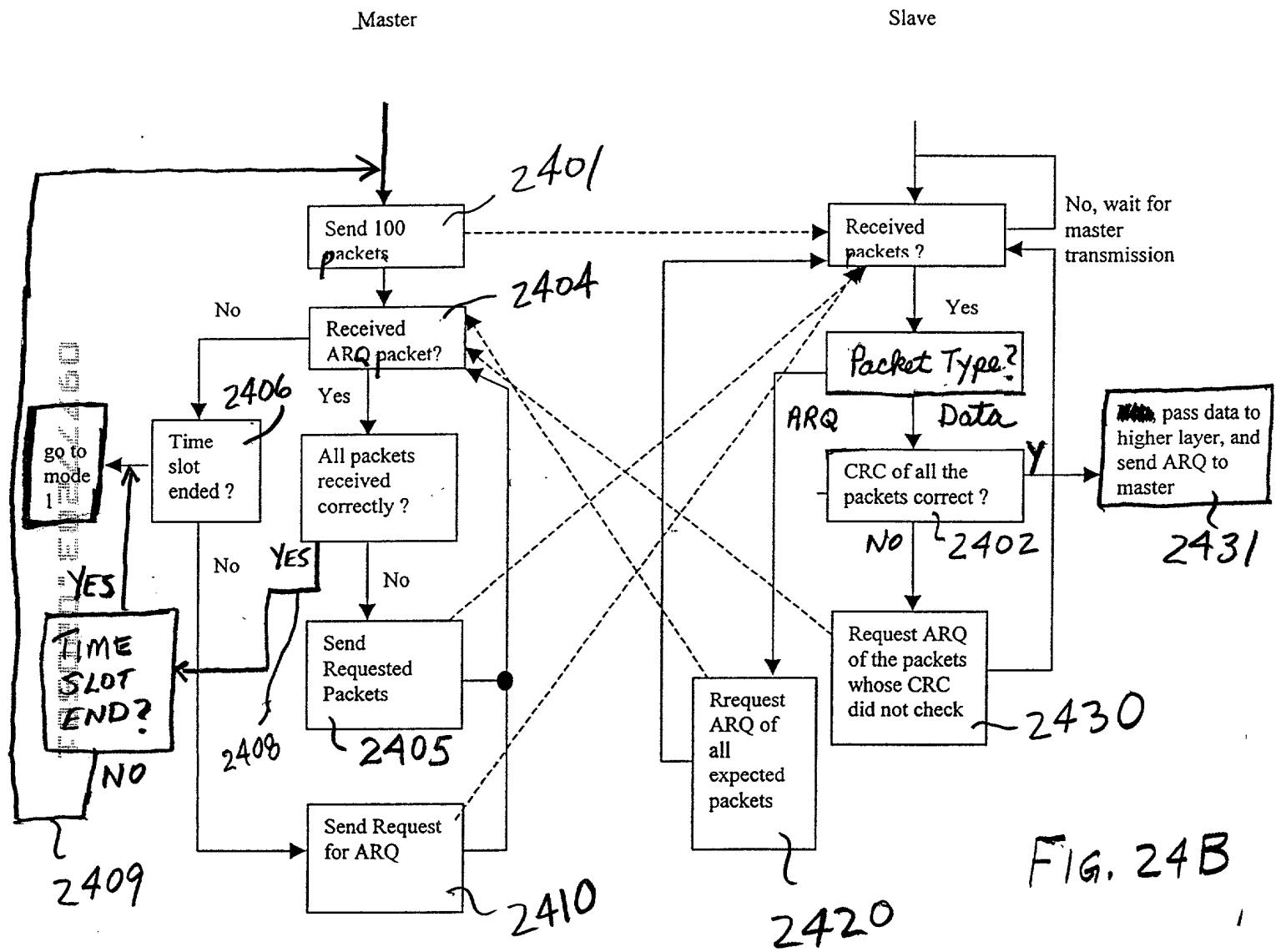


FIG. 24B

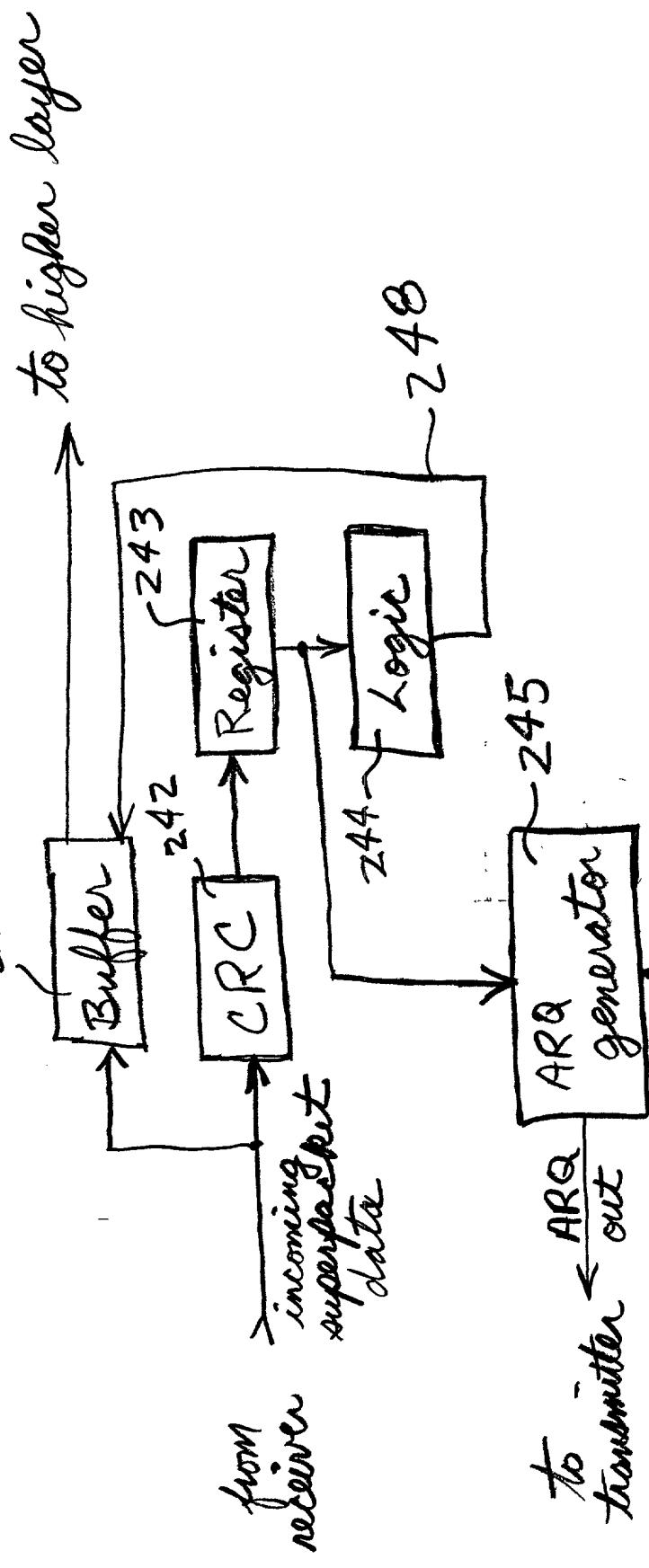
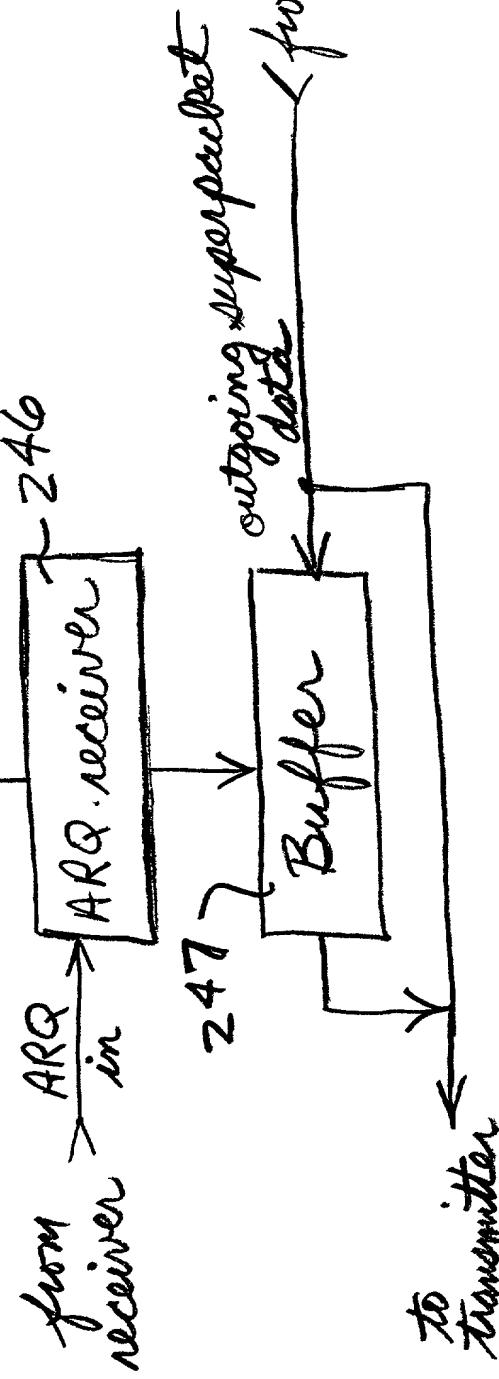


FIG. 24C



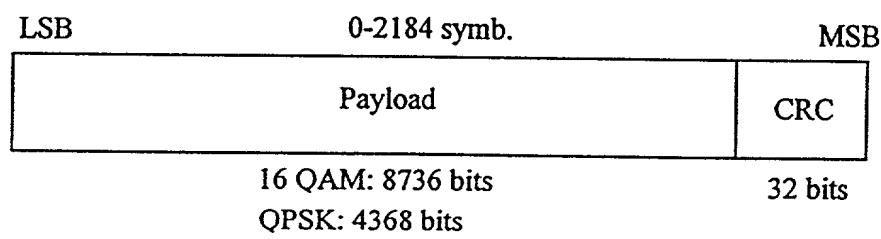


Figure 25

| 22 symb.                 | 32 symb.                     | 27 symb.                 |
|--------------------------|------------------------------|--------------------------|
| Preamble<br>2 $\mu$ sec. | Sync. Word<br>2.9 $\mu$ sec. | Header<br>2.45 $\mu$ sec |
| 44 bits                  | 64 bits                      | 54 bits                  |

Figure 26

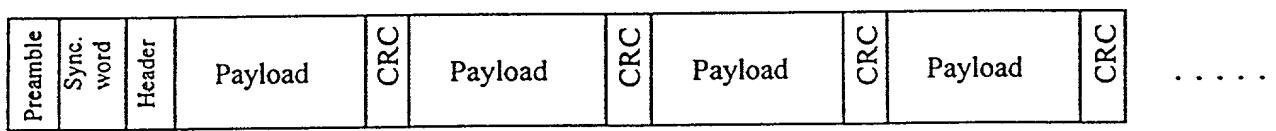


Figure 27

| MPEG2 HDTV Video transmission using Mode 3      |                                     |
|---|-------------------------------------|
| Video data rate                                 | 18 Mbps                             |
| Video frames/sec                                | 24                                  |
| Video frames/Mode 3 slot                        | 6                                   |
| Mode 3 data rate                                | 44 Mbps, 11 MSPS                    |
| Coding  | Rate $\frac{1}{2}$ , Turbo          |
| Modulation                                      | 16 QAM                              |
| Time in Bluetooth mode ( $T_1$ msec.)           | 25 msec.                            |
| Time in Bluetooth mode for other devices        | 17.5 msec.                          |
| Time in Bluetooth mode for PAL                  | 7.5 msec.                           |
| Slot time in Mode 3 ( $T_2$ msec.)              | 225 msec.                           |
| Mode 3 packet size                              | 4.4 Kbits                           |
| Data bits/packet                                | 4368                                |
| CRC bits/packet                                 | 32                                  |
| Mode 3 packet length                            | 200 $\mu$ sec.                      |
| Number of packets/slot                          | 1030                                |
| Length of training sequence                     | 81 symbols, 7.36 $\mu$ sec.         |
| Number of packets/training sequence             | 10                                  |
| Number of packets/ARQ                           | 100                                 |
| Number of training sequences/packet             | 103                                 |
| Time required to transmit video frames (no ARQ) | $204.5 + 1.5 + 0.76 = 206.76$ msec. |
| ARQ rate  | 9 %                                 |
| Time required to transmit video frames with ARQ | 225 msec.                           |

Figure 28

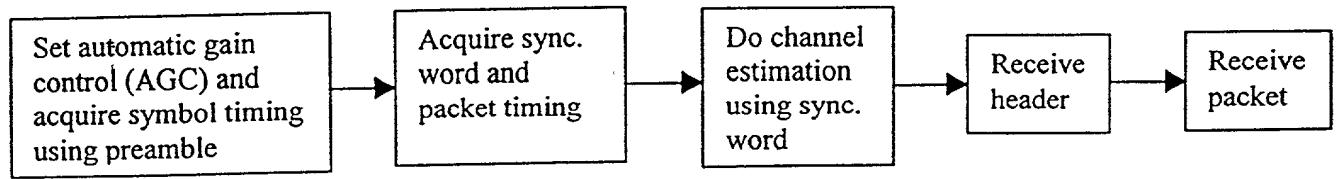


Figure 29

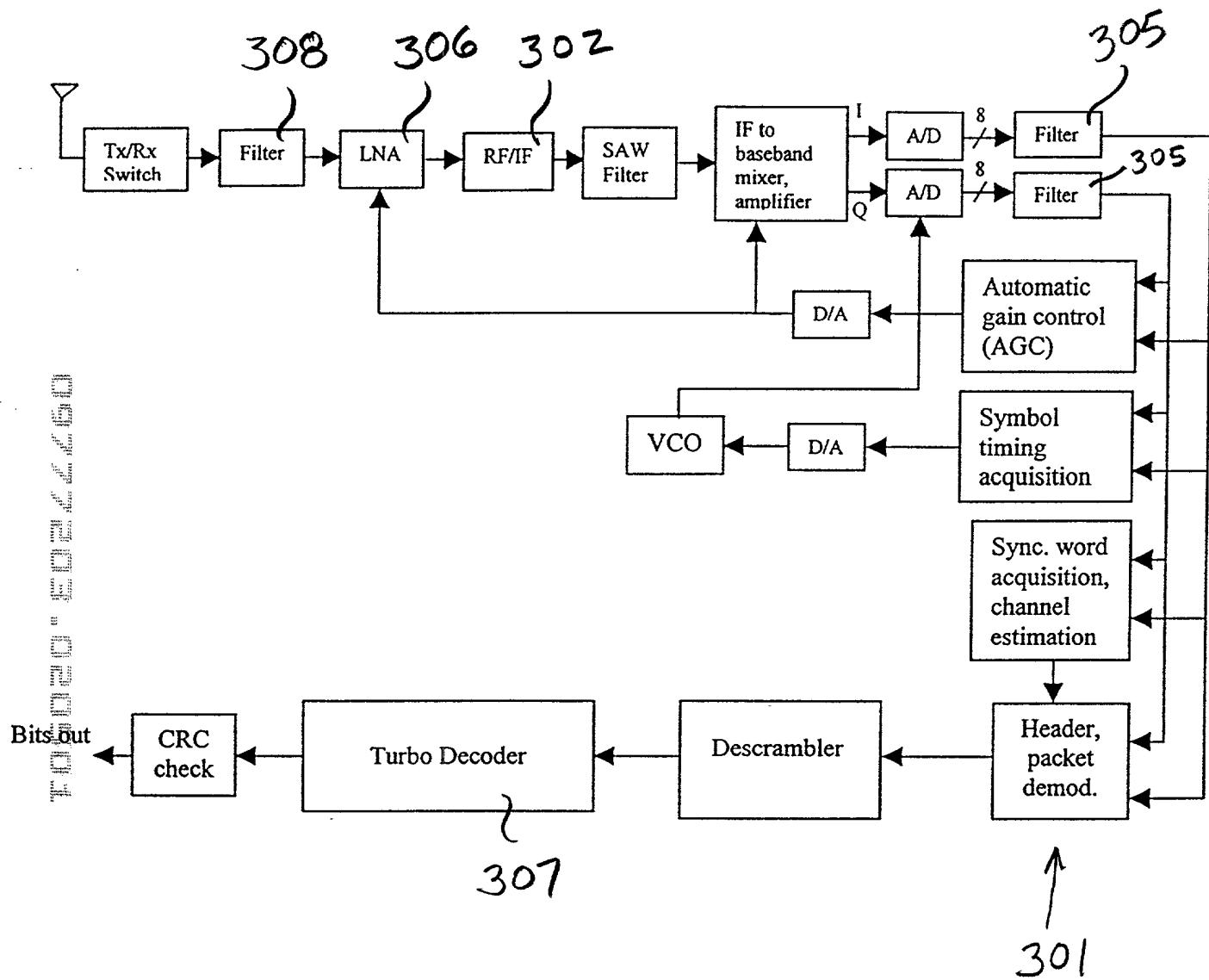


Figure 30

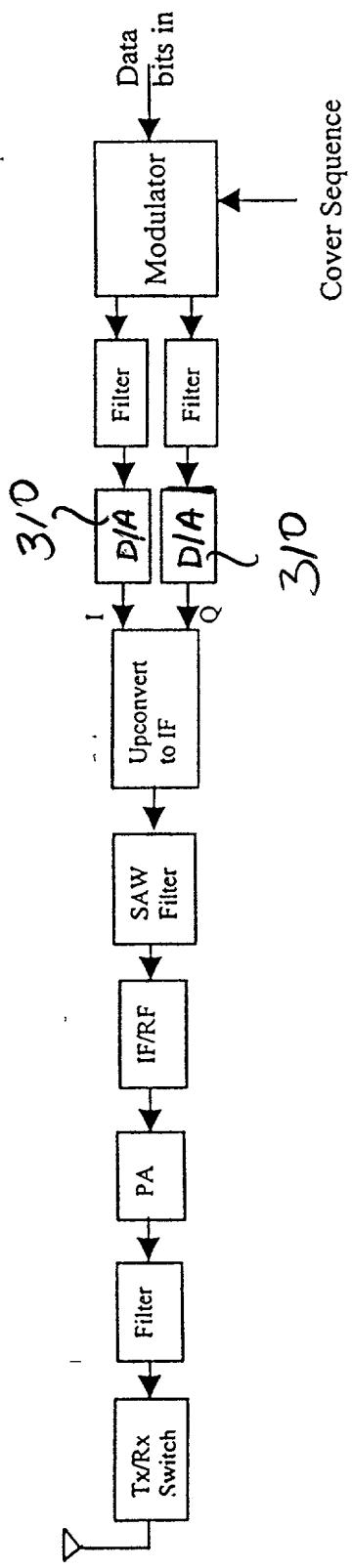


Figure 31

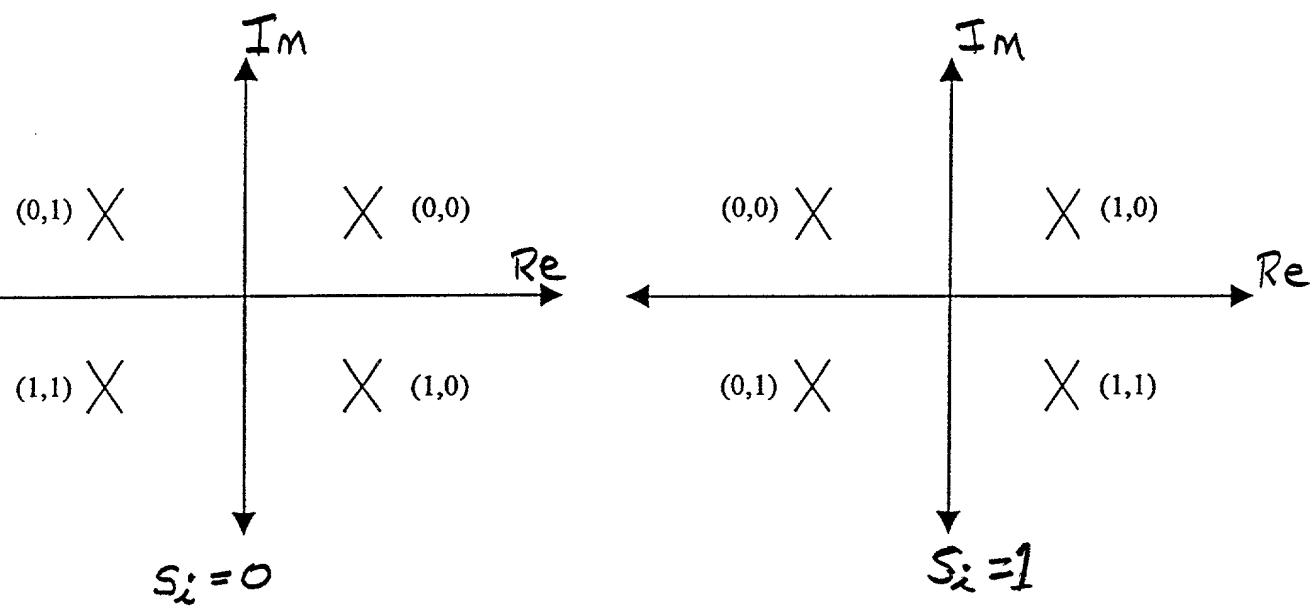


Figure 32

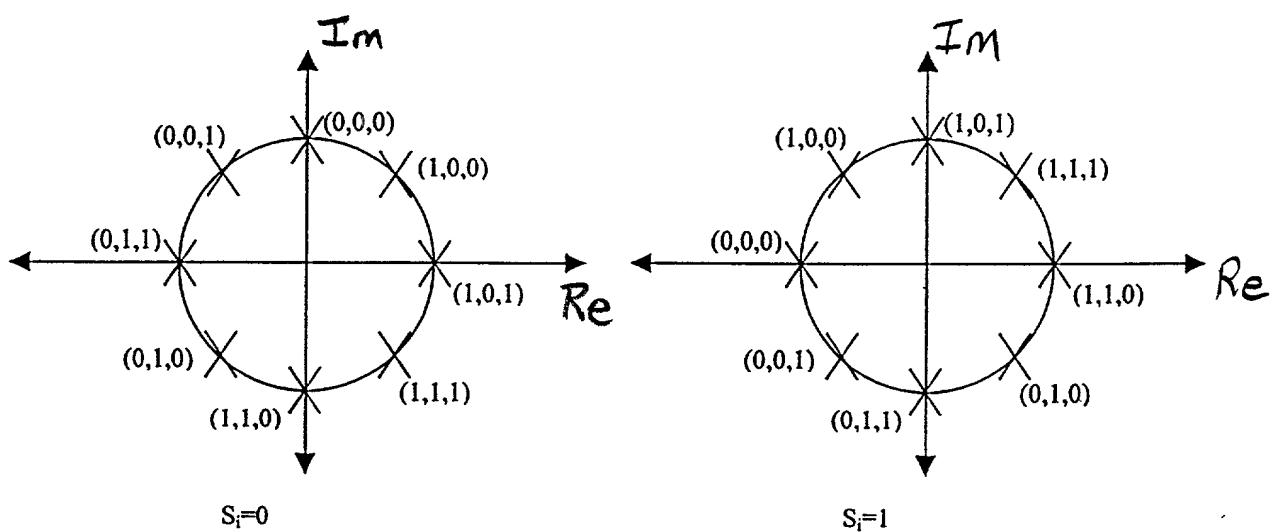


FIG. 32A

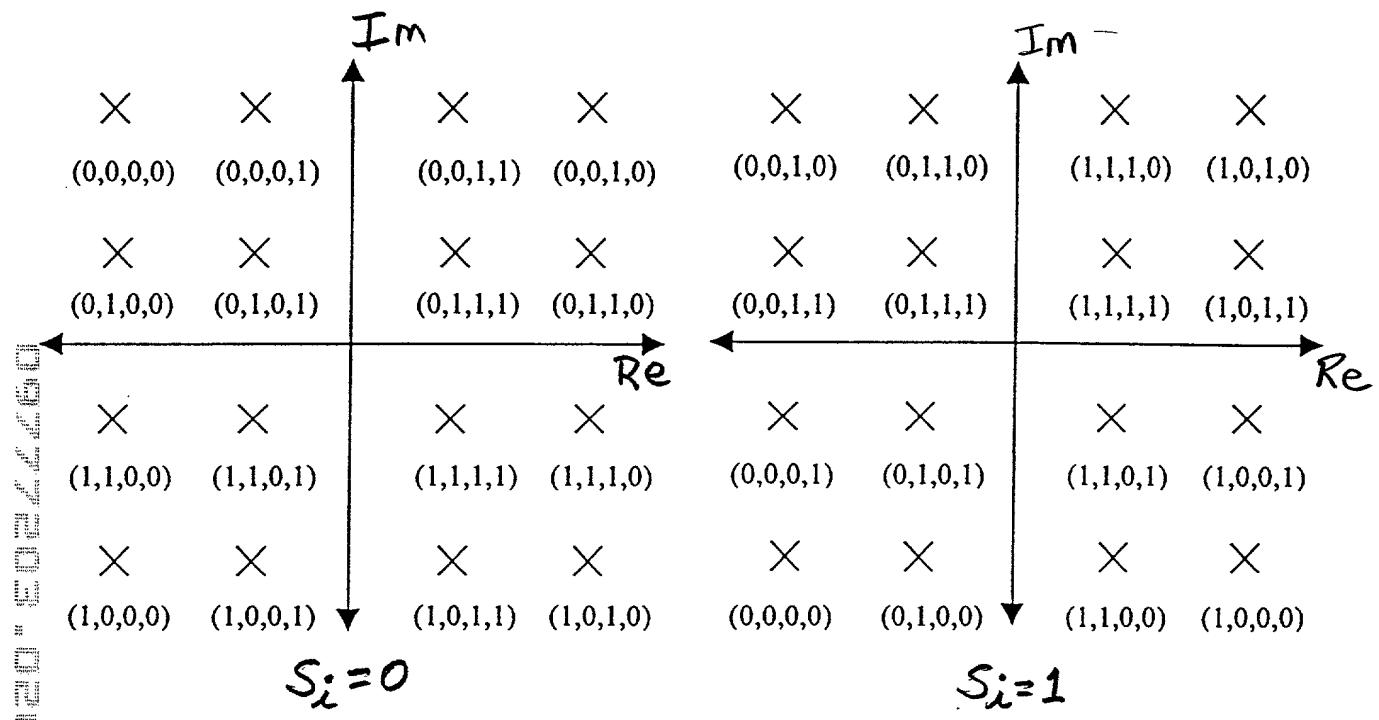


Figure 33

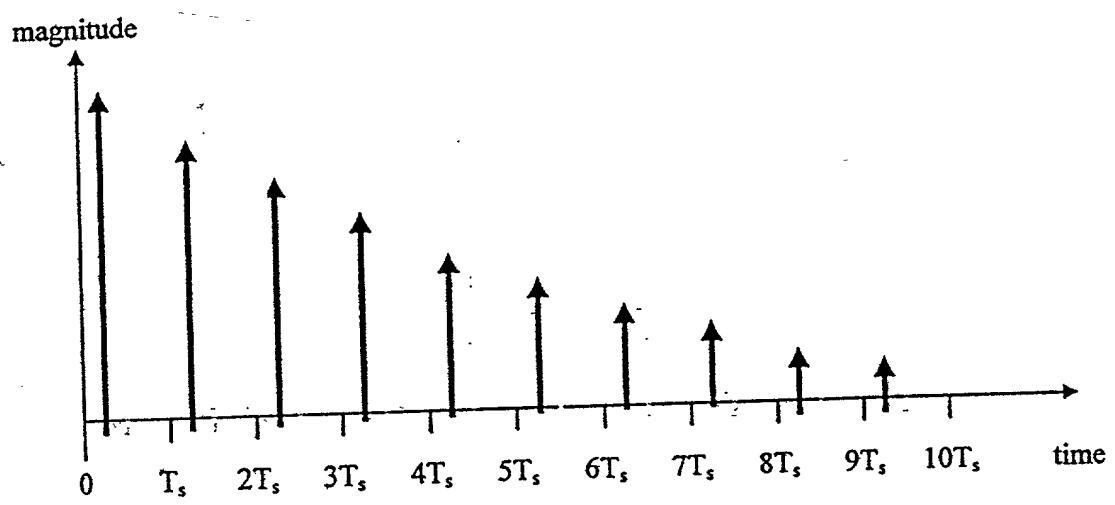


Figure 34

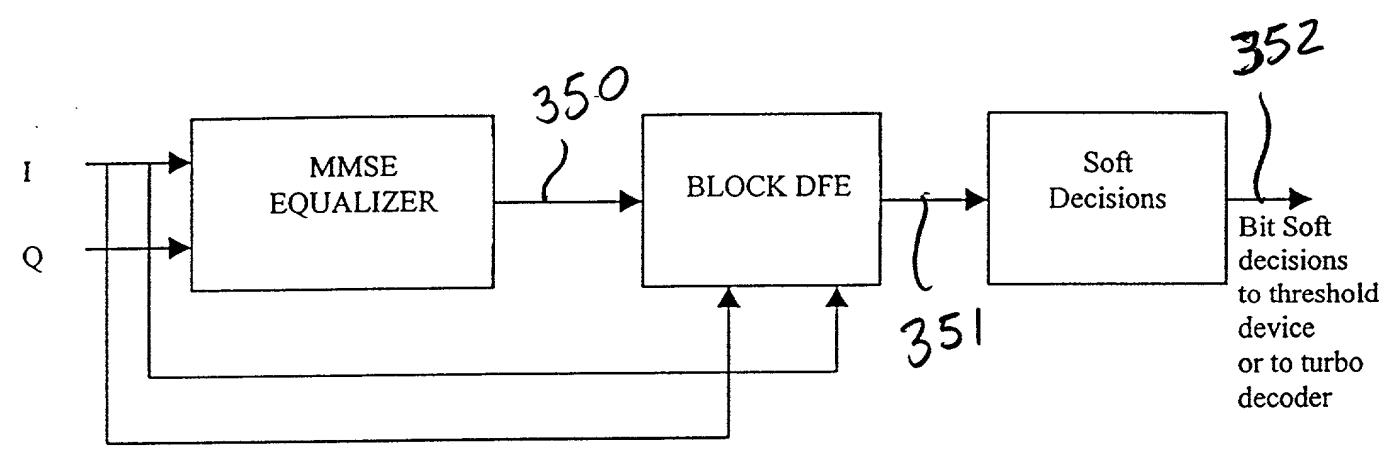


Figure 35

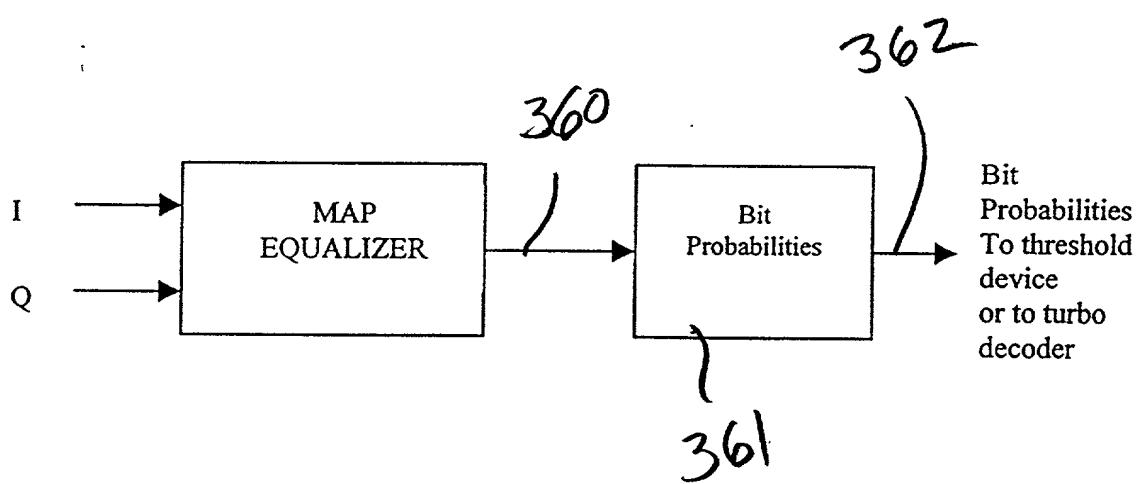


Figure 36

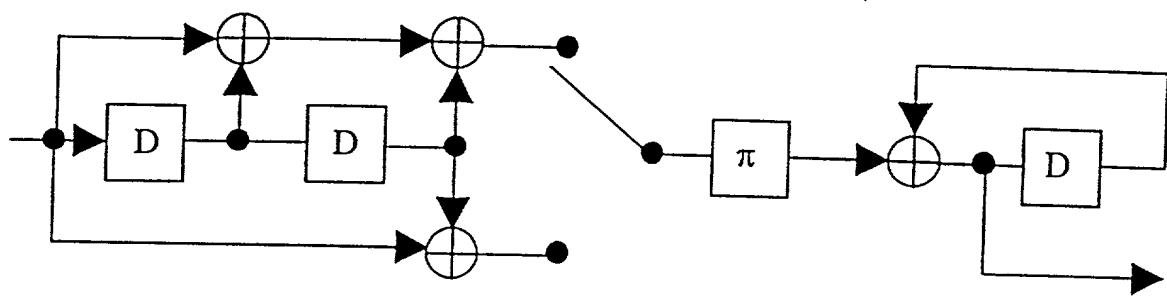


Figure 37

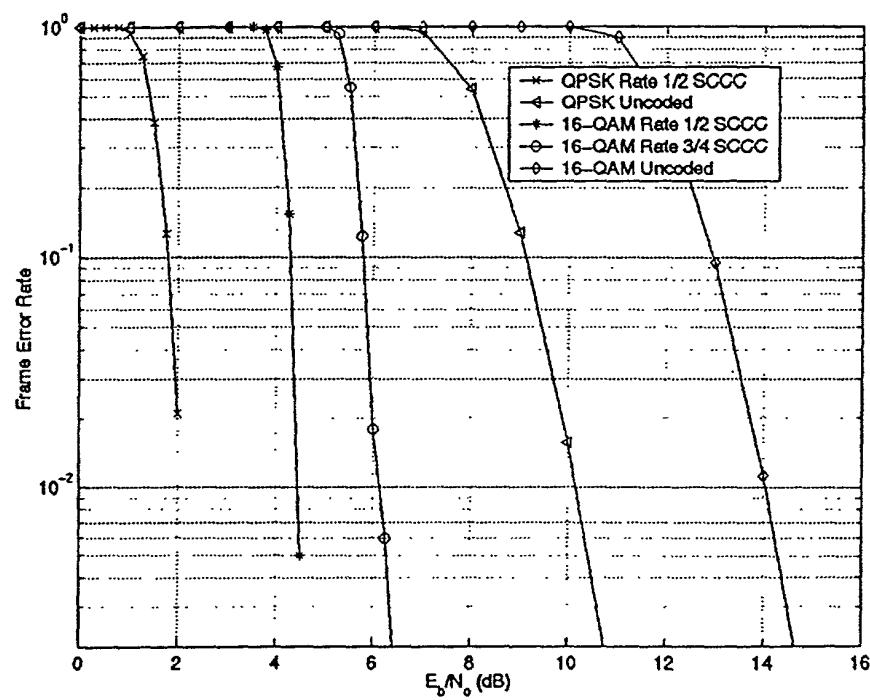


Figure 38

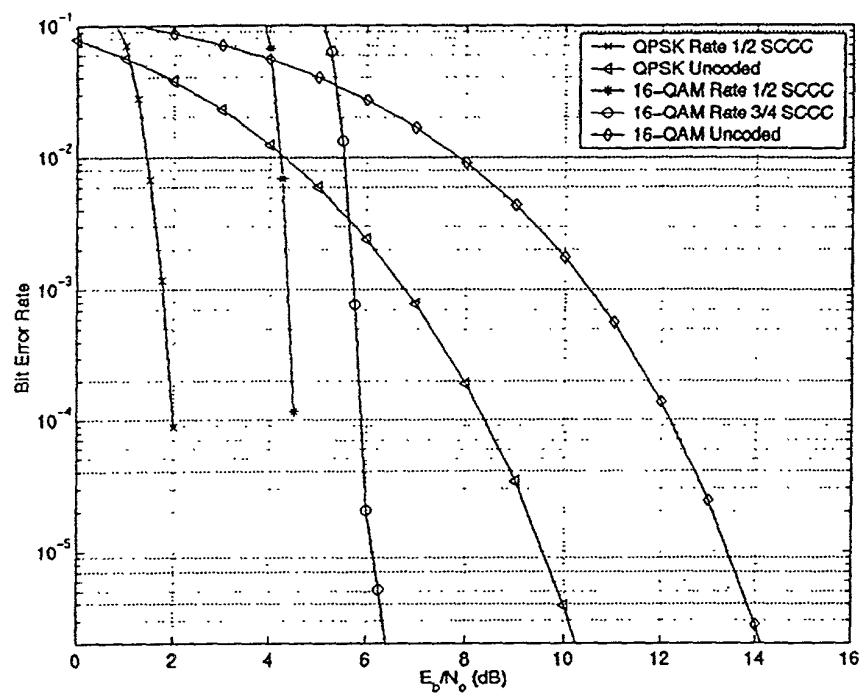


Figure 39

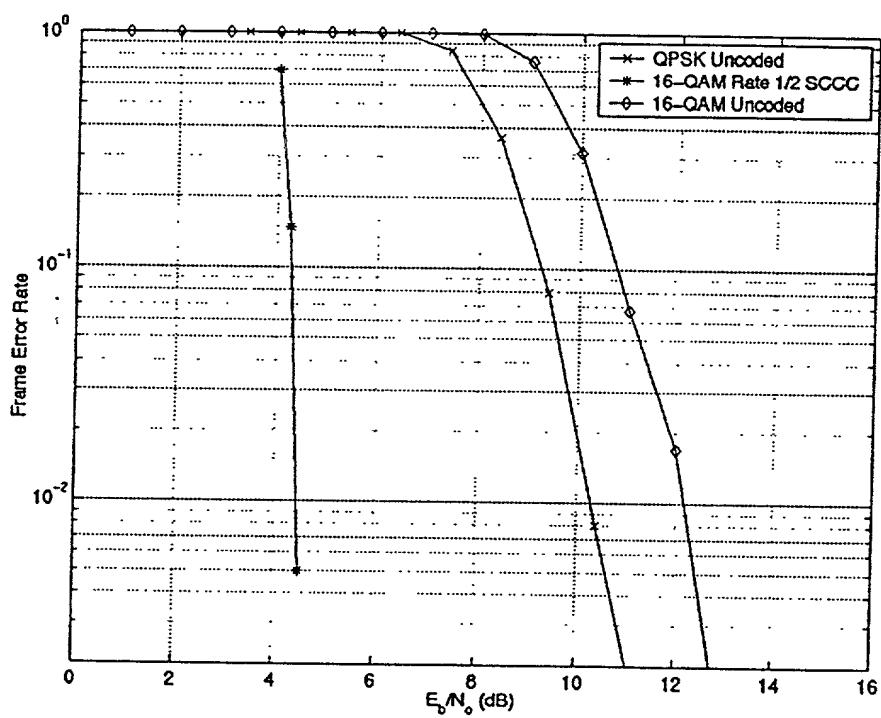


Figure 40

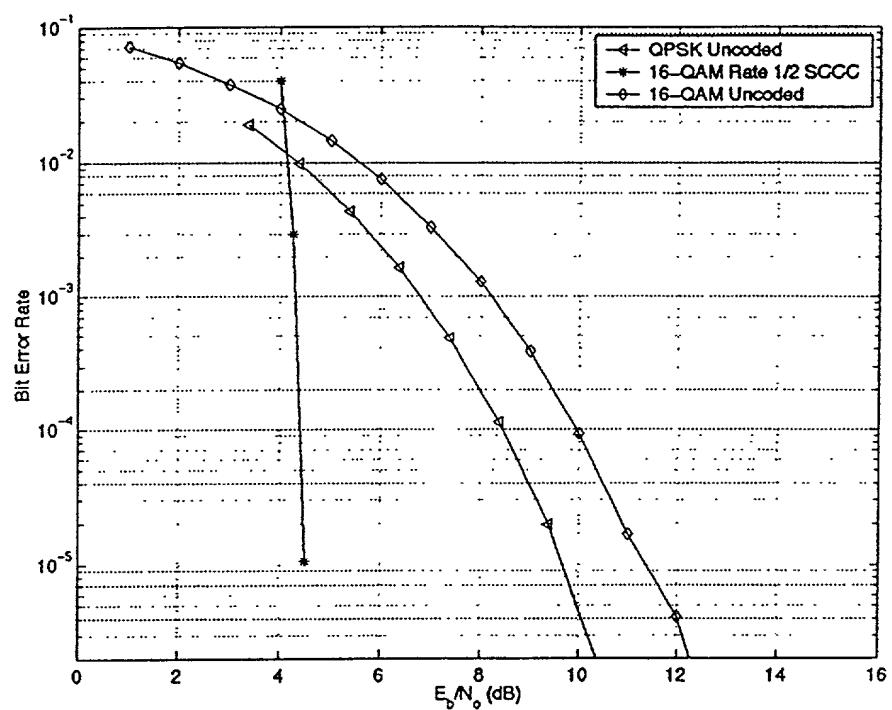


Figure 41

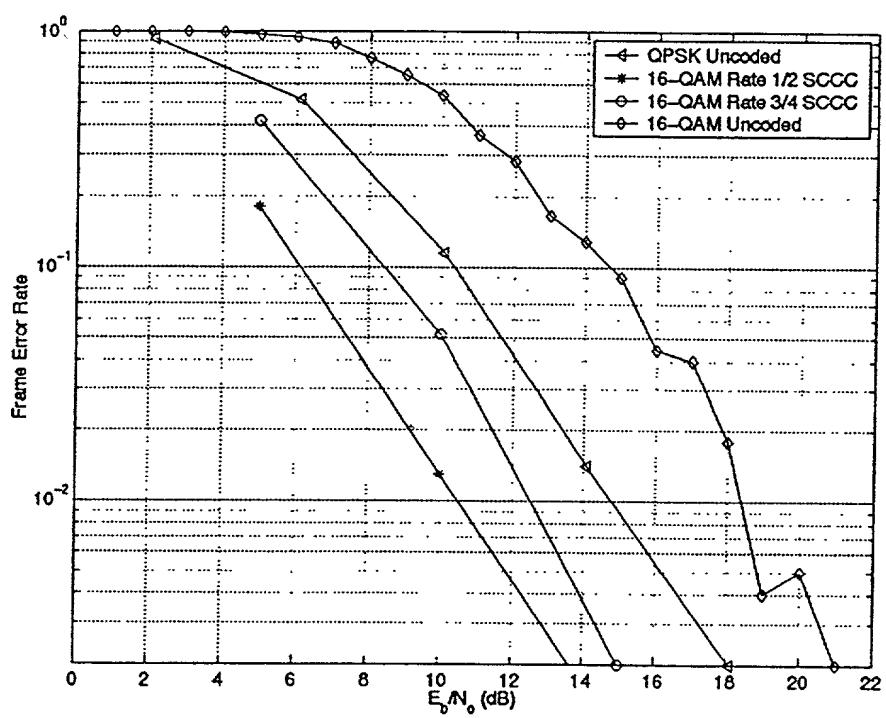


Figure 42

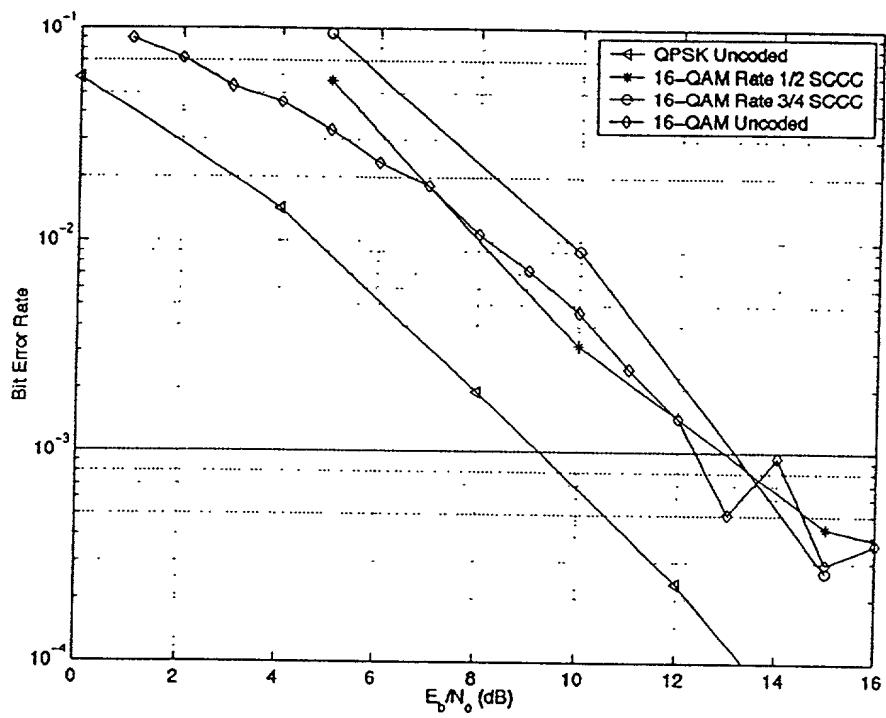


Figure 43

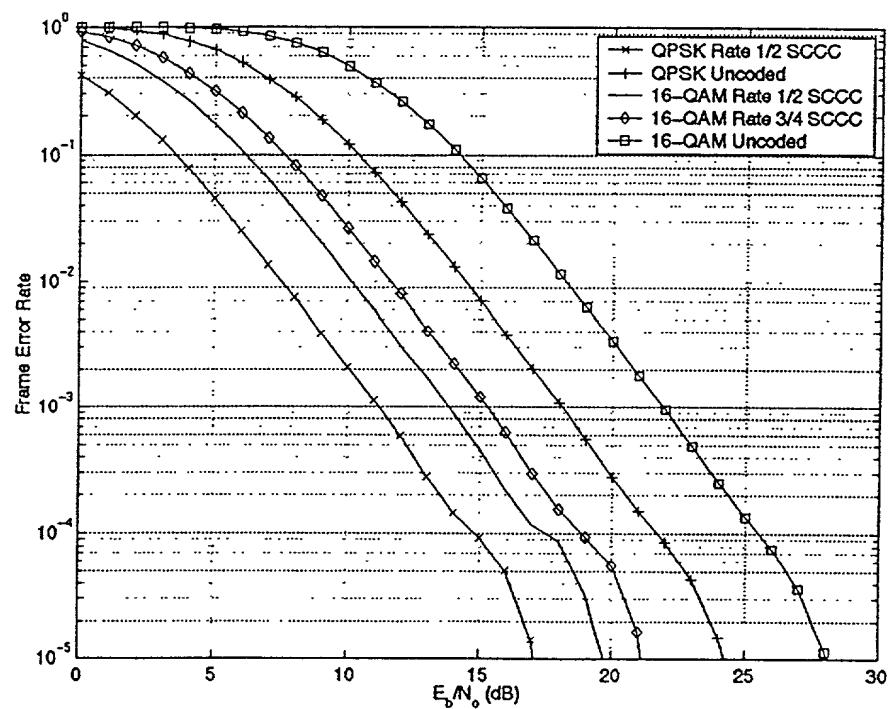


Figure 44